The University of Alberta
Printing Department
Edmonton, Alberta

Digitized by the Internet Archive
in 2017 with funding from
University of Alberta Libraries

https://archive.org/details/andersen1971

THE UNIVERSITY OF ALBERTA

AN ECONOMIC ANALYSIS OF DAILY HOG PRICE FLUCTUATIONS AND SUPPLY RESPONSE

by

RICHARD S. ANDERSEN

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY

EDMONTON, ALBERTA

SPRING, 1971

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read and recommend to the Faculty of Graduate Studies for acceptance a thesis entitled "An Economic Analysis of Daily Hog Price Fluctuations and Supply Response," submitted by Richard S. Andersen in partial fulfilment of the requirements for the degree of Master of Science.

M. Hawkins

Supervisor

R. T. Berg

Date April 23/71

ABSTRACT

Erratic price and quantity fluctuations pose problems for agricultural commodity marketing agencies. This thesis attempts to identify the pricing relationships existing in the Canadian hog industry and to determine statistically whether or not price information flows exist in the national market. An effort is also made to develop a daily supply model in order to forecast the day-to-day changes in hog supply for the Edmonton market area.

Price determination is a subject that commands the attention of many individuals connected with hog production and marketing in Alberta. Numerous misunderstandings about the means and methods of hog price establishment in Alberta are prevalent in the industry. The widespread notion that Alberta hogs are priced Toronto less freight would not appear to be statistically significant. The production and marketing of hogs in Alberta appear to operate on a regional basis, the major influences being short-run regional supply and demand conditions and dependency of the hog market on export markets, hence, on United States prices.

The day-to-day change in hog supply at the Edmonton market appears to be tied directly to traditional delivery patterns. Consequently, the major variables affecting supply change are the days of the week, represented in this thesis by dummy variables. Established delivery patterns in the market area overshadow such variables as price changes, weather conditions, and other variables involved in hog production.

The models developed show an average absolute percentage error in predicting supply change of anywhere from 27 to 56 percent. They do, however, predict the correct directional change in supply for more than 90 percent of the days analyzed. Thus if the main objective of the forecaster is predicting directional change, the models developed may be useful. However, if the forecaster is involved in predicting actual supply change, numerous refinements to the models would appear necessary in order to increase the accuracy of the forecasts.

ACKNOWLEDGEMENTS

Many people deserve credit and thanks for assistance given in doing the research for this thesis and in preparing this manuscript. Deepest appreciation is extended to Dr. M. H. Hawkins, who initiated the research along with the Alberta Hog Producers Marketing Board, provided guidance and encouragement in the writing of the thesis, and displayed a never-ending interest in my work and my future. Appreciation for financial assistance is extended to the Alberta Hog Producers Marketing Board and the Alberta Agricultural Research Trust.

I would also like to thank Dr. W. E. Phillips, Mr. C. A. Shier, and Mr. L. A. Malmberg for the assistance they provided in the technical aspects of the study. Many thanks go to Mrs. L. Cartmell, who typed several drafts of the manuscript, and to Mrs. K. Hohn for her expert literary criticisms.

Above all I would like to thank my wife, Sherry, and our children, Kym and Sean, who sacrificed many hours of family enjoyment so that this thesis could become a reality.

TABLE OF CONTENTS

Page

ABSTRACT iii

ACKNOWLEDGEMENTS v

LIST OF TABLES viii

LIST OF FIGURES x

CHAPTER

I. INTRODUCTION 1

The Need for the Study 1
Purposes of the Study 2
Basic Hypotheses 3
Data Collection and Sources 5
Weaknesses of the Study 6
Organization of the Thesis 7

II. THE STRUCTURE OF THE ALBERTA HOG INDUSTRY 8

Size and Location 8
Structure Prior to 1969 11
Formation of the Alberta Hog Producers Marketing Board 15

III. LITERATURE REVIEW 20

Major Studies 20
Daily Studies 22

IV. DAILY HOG PRICE ANALYSIS 25

Prices and Market Reports 25
Terminal Market Prices 31
Daily Hog Price Relationships, 1969-1970 57

V. THEORETICAL FRAMEWORK FOR THE SUPPLY MODEL 68

Basic Assumptions 69
The Supply Function 71
Functional Form 76
Statistical Assumptions 77

CHAPTER Page

VI. APPLICATION OF THE SUPPLY MODEL TO THE EDMONTON MARKET AREA 80

Discussion of Data Utilization 80
Model Alterations 83
Selection of a Model 85
Estimation Results 86

VII. SUMMARY AND RECOMMENDATIONS 106

Summary of Hypotheses and Conclusions 106
Policy Implications 112
Recommendations for Further Research 113

BIBLIOGRAPHY 114

APPENDIX A 117

CHAPTER Page

VI. APPLICATION OF THE SUPPLY MODEL TO THE EDMONTON MARKET AREA 80

Discussion of Data Utilization 80
Model Alterations 83
Selection of a Model 85
Estimation Results 86

VII. SUMMARY AND RECOMMENDATIONS 106

Summary of Hypotheses and Conclusions 106
Policy Implications 112
Recommendations for Further Research 113

BIBLIOGRAPHY 114

APPENDIX A 117

LIST OF TABLES

Table — Page

2-1 Percent of Commercial Hog Slaughter and Estimated Value of Hogs Sold by Major Hog Producing Provinces, 1967-1968 — 11

2-2 Alberta Live Hogs Delivered to Yards and Plants by Crop Reporting District, 1968 — 13

4-1 Correlation Coefficients of Daily Price Levels and Price Changes for Three Terminal Markets With Each Market in Time t, 1967-1968 — 44

4-2 Correlation Coefficients of Daily Price Changes for Three Terminal Markets With One Market Lagged One, Two, and Three Days, 1967-1968 — 47

4-3 Average Daily Price Difference of Grade A Dressed Weight Hogs in Dollars Per Hundredweight From Three-Market Average, 1967-1968 — 48

4-4 Average Daily Price Difference of Grade A Dressed Weight Hogs in Dollars Per Hundredweight Between Each of the Three Terminal Markets, 1967-1968 — 48

4-5 Yearly Average Weights of Grade A Dressed Weight Hogs for Three Terminal Markets, 1967-1968 — 49

4-6 Statistical Summary — 55

4-7 Correlation Coefficients of Daily Price Levels and Price Changes for Three Terminal Markets With Each Market in Time t, 1969-1970 — 61

4-8 Correlation Coefficients of Daily Price Changes for Three Terminal Markets With One Market Lagged One, Two, and Three Days, 1969-1970 — 63

4-9 Average Daily Price Difference of Dressed Weight Hogs in Dollars Per Hundredweight From Three-Market Average, 1969-1970 — 64

4-10 Average Daily Price Difference of Dressed Weight Hogs in Dollars Per Hundredweight Between Each of the Three Terminal Markets, 1969-1970 — 65

6-1 Results of Supply Equation Estimations for the Edmonton Market, 1967-1968 Dependent Variable: ΔQ_t — 88

Table Page

6-2 Supply Equation Variables With Corresponding Coefficient Ranges, Based on 1967-1968 Data 91

6-3 Summary by Months of Supply Prediction Errors for Each Market Day of 1968 for the Edmonton Market Area 99

LIST OF FIGURES

Figure		Page
2-1	Sources of Farm Income, 1968	9
4-1	Hog Industry Marketing Channels, 1968 and 1969	27
4-2	Edmonton, Toronto and Winnipeg Daily Hog Prices for 1967	33
4-3	Edmonton, Toronto and Winnipeg Daily Hog Prices for 1968	34
4-4	Toronto and Winnipeg Daily Highs 1967	36
4-5	Toronto and Winnipeg Daily Lows 1967	37
4-6	Toronto and Winnipeg Daily Highs 1968	38
4-7	Toronto and Winnipeg Daily Lows 1968	39
4-8	First Differences at Edmonton, Toronto and Winnipeg, 1967	40
4-9	First Differences at Edmonton, Toronto and Winnipeg, 1968	41
4-10	Toronto and Edmonton Intermarket Price Spreads, 1962-1970	51
4-11	Winnipeg and Edmonton Intermarket Price Spreads, 1962-1970	52
4-12	Toronto and Winnipeg Intermarket Price Spreads, 1962-1970	53
4-13	Edmonton, Toronto and Winnipeg Daily Hog Prices for 1969/70	59
4-14	First Differences at Edmonton, Toronto and Winnipeg, 1969/70	60
4-15	Hog Price Spreads, Toronto-Winnipeg, Toronto-Edmonton, Winnipeg-Edmonton 1969/70	66
5-1	Major Relationships in the Hog Economy	70
6-1	Total Supply of Live Hogs to Edmonton Terminal Market by Months, 1967-1968	82

Figure		Page
6-2	Actual and Predicted Daily Hog Supplies Edmonton, Jan. to Mar. 1968	101
6-3	Actual and Predicted Daily Hog Supplies Edmonton, Apr. to June 1968	102
6-4	Actual and Predicted Daily Hog Supplies Edmonton, July to Sept. 1968	103
6-5	Actual and Predicted Daily Hog Supplies Edmonton, Oct. to Dec. 1968	104

CHAPTER I

INTRODUCTION

The Need for the Study

Agricultural commodities are characterized by frequent and severe price and quantity fluctuations. The Canadian live hog market is continually plagued by these erratic and irregular variations. The Alberta Hog Producers Marketing Board, representing the swine industry in Alberta, recognized the need for relevant short-run price and supply analysis in order to reduce the impact of such undesirable fluctuations on the live hog market. Past research has focused on long-run price trends and recurrent price variations, cycles, and seasonal patterns with relatively little research being conducted on short-run or daily variations. Consequently, the causes and pattern of these latter price and quantity movements are relatively unknown. Initiated by the Board, this study proposes to fill the research gap by examining and analyzing daily hog price and quantity fluctuations in Canada and Alberta.

The 1966 U.S. National Commission on Food Marketing emphasized the need for more market information on the daily level. The commission report stated that

> farmers and feeders need short-run information to help them decide which market to use, which buyer to deal with, how to judge quality characteristics of different animals, and what prices to expect.[1]

The Alberta Hog Producers Marketing Board and other marketing firms similarly require accurate, up-to-date information on which to base

---

[1] Food from Farmer to Consumer, A Report of the National Commission on Food Marketing (Washington: U.S. Government Printing Office, June, 1966), p. 21.

their day-to-day marketing decisions. This study attempts to give both direct and indirect market participants valuable daily marketing information by investigating the pricing relationships that exist among various hog markets in Canada and by examining factors affecting the quantity fluctuations in one of these markets, namely, the Edmonton terminal market.

Purposes of the Study

The first purpose of this study was to perform a price analysis on the live hog market in Canada in order to determine the interrelationships among spatially separated hog markets. An investigation of information flows which might affect the pricing patterns defined in these markets was also performed. The price patterns examined in the thesis were those established at the public terminal hog markets located in Toronto, Winnipeg, and Edmonton. These three markets are the major hog slaughtering concentration points in Canada.

A comparison was also drawn between pricing patterns in the previously mentioned markets both prior to and after 1969, when the newly formed Alberta Hog Producers Marketing Board assumed the hog selling function in the province. The Marketing Board also took over from the terminal market system the function of reflecting the most accurate available price for live hogs.

By focusing on more than one market, this study was able to examine interregional pricing patterns and investigate price influences and informational flows among terminal markets. Such an analysis could not have been performed solely on individual markets; consequently, this study provides a more comprehensive analysis than previous work on

short-run hog price variations done in the United States. These earlier studies concentrated basically either on individual markets or on a few markets in a local area.

The second and primary purpose of this thesis was to examine the economic factors affecting daily quantity variations on the Edmonton terminal market. Economists and researchers have developed models to explain and forecast hog supplies for quarter years or for yearly time periods, but formal analysis has rarely been used to devise daily forecasting models. Utilizing information derived from the price differential analysis described above, an attempt was made to develop a model with which to explain and predict daily supply of hogs on the Edmonton terminal market. Multiple regression analysis and dummy variables were the statistical tools employed in developing this forecasting model.

Basic Hypotheses

The supply model developed in the thesis is based on the hypothesis that daily supply of hogs is affected by the following independent variables:

1) expected price of live hogs,
2) changes in weather conditions,
3) holidays,
4) wage rate of farm labor,
5) price of capital (interest rate),
6) price of feed,
7) price of feeder pigs,
8) day of the week,

9) season of the year, and

10) number of live hogs available for marketing.

Numerous subsidiary hypotheses were tested throughout the analysis. It was hypothesized that differences in dressed weight hog prices as quoted among the three terminal markets examined were reflected solely by the freight rate differentials among these spatially separated markets. Similarly, it was hypothesized that the western markets (Edmonton and Winnipeg) were dependent upon the Toronto market for the reflection of their dressed hog prices. This supposition was based on the fact that the Toronto market opens some two to three hours before the western markets and quotes an established dressed weight hog price prior to their opening. West to east price flows likely exist; therefore, the hypothesis that eastern prices (Toronto based) reflected the previous day's western prices was proposed and tested.

Through the development of the short-run supply model as hypothesized above, a general hypothesis on the exchange and operational efficiencies of the hog market in Alberta was formulated. Producers, marketing firms, and, in particular, the Alberta Hog Producers Marketing Board strive for increased operational efficiency. Operational efficiency in this case is measured quantitatively by the day-to-day costs of marketing hogs from the farmer to the packinghouse.[1] Thus it includes costs for assembly, transportation, handling, and selling of live hogs in the marketing channel. The increase in operational efficiency was hypothesized to result from the removal of some of the aforementioned

---

[1] Appendix A is devoted to a thorough discussion of the concepts of exchange efficiency and operational efficiency as they apply to this analysis.

procurement and selling activities formerly duplicated by numerous marketing firms within the industry.

It was further hypothesized that pricing efficiency in the industry would increase. This hypothesis was based on the fact that under the new system of selling hogs, all buyers in the province can bid on all hogs being sold in the province resulting in a more competitive live hog market. To test this hypothesis, a price differential analysis was performed both prior to and following the formation of the Alberta Hog Producers Marketing Board.

Data Collection and Sources

The daily supply data utilized in the study were collected by the author and one other person while employed by the Alberta Hog Producers Marketing Board in the summer of 1969. This delivery data covers the 1967 and 1968 calendar years and is supplemented by more recent data covering a six-month period beginning in February of 1970. This latter set of data was acquired from the daily summary report of the Alberta Hog Producers Marketing Board.

Daily price data used in the study were gathered from one primary source. The Markets Information Branch of the Canada Department of Agriculture publishes a daily market report quoting dressed weight hog prices in the major hog markets in Canada. All prices for the price differential analysis were acquired from this report.

Weather data on a daily basis covering the analytic time period were gathered from Department of Transport meteorological reports.[1]

---

[1] Canada Department of Transport, Monthly Record: Meteorological Observations in Canada (Toronto: Canada Department of Transport, Meteorological Branch, 1967 and 1968).

Daily high and low temperatures and daily precipitation rates were believed to be representative of weather conditions in the Edmonton area. Further data sources corresponding to independent variables utilized in the supply model are listed in Chapter VI along with a description of the data and its use in the supply equation.

Weaknesses of the Study

The basic weakness of any study of this type stems from the difficulties inherent in acquiring accurate and reliable daily price and quantity data. The delivery data utilized in the study include the majority of hogs delivered daily to packing plants and terminal markets in Alberta. This data, however, was taken off daily shipping manifests which do not take hogs shipped directly to packing plants by individual producers into account. Because it was impossible to acquire reliable data on direct producer shipments, the daily supply figures employed were assumed to be representative of the delivery pattern of hogs in 1967 and 1968. The short-run supply forecasting model was developed on these figures.

The price data used in this study are likewise open to criticism. The daily hog prices used for the Edmonton market were those established and quoted at the Edmonton public stockyards.[1] The prices for Winnipeg and Toronto, as quoted by their respective Hog Boards, were given in a

---

[1] The daily hog prices as quoted on the Edmonton public stockyards are not indicative of the true price of Edmonton hogs. Because of the numerous pricing strategies employed by meat packers in the Edmonton area, no true dressed weight hog price is known. It was assumed for our purposes, however, that the bias between the true hog price received by producers and the actual price as quoted on the public yards was consistent and that the prices utilized in the study reflect dressed weight price changes in the market.

range. The problem of assigning a price within this range as representative of the true hog price arose. For our purposes, the mean price in the range was assumed to be indicative of the price of hogs on any particular day. A test to demonstrate the reliability of the above assumption is performed in Chapter IV.

A further weakness of the study lies in the apparent elimination of Montreal and Calgary hog prices from the price differential analysis. This elimination may be attributed solely to the lack of price data comparable to that utilized in the study. Likewise, no United States markets were examined because of the inability to acquire similar daily price data. Inclusion of more markets in the study would have been helpful for the sake of comparison; however, it is felt that such a broadening in the scope of the thesis would have had little effect upon the results of the analysis.

Organization of the Thesis

The following chapter contains a description of the market structure of the hog industry in Alberta as it existed in 1968. An historical development of the present market structure operating under the Alberta Hog Producers Marketing Board completes the chapter. Chapter III includes a detailed review of pertinent literature. In Chapter IV, a price differential analysis is performed, and price information flows among the three terminal markets are identified. The theoretical framework of an economic supply model is developed in Chapter V. Chapter VI contains a description of estimation results of the supply model and supply forecasts for the Edmonton terminal market. The thesis concludes with a summary and recommendations for future research.

CHAPTER II

THE STRUCTURE OF THE ALBERTA HOG INDUSTRY

The structure of the Alberta hog industry underwent major alteration during 1968 and 1969. The hog industry structure changed from a traditional terminal market system to the present system operating under the Alberta Hog Producers Marketing Board. This chapter outlines the structure of the industry as it existed prior to the change and concludes with the development of the industry structure as it presently exists under the auspices of the Alberta Hog Producers Marketing Board. A comparison between the two structures is crucial to our analysis. Pricing patterns and informational flows under each structure are identified and analyzed. Any efficiencies that have been realized in the industry subsequent to the change in market structure may be attributed to this change.

Size and Location

The hog industry constitutes an important segment of Alberta agriculture. In 1968, the estimated value of hogs sold on public stockyards, shipped direct to packers, or sold direct on export exceeded 72.3 million dollars, compared to 58.3 million dollars in 1964.[1] The only livestock sector in Alberta to exceed this dollar output was cattle and calves with a value of 321.4 million dollars. Figure 2-1 gives a graphic presentation of the sources of farm income by industry in Alberta.

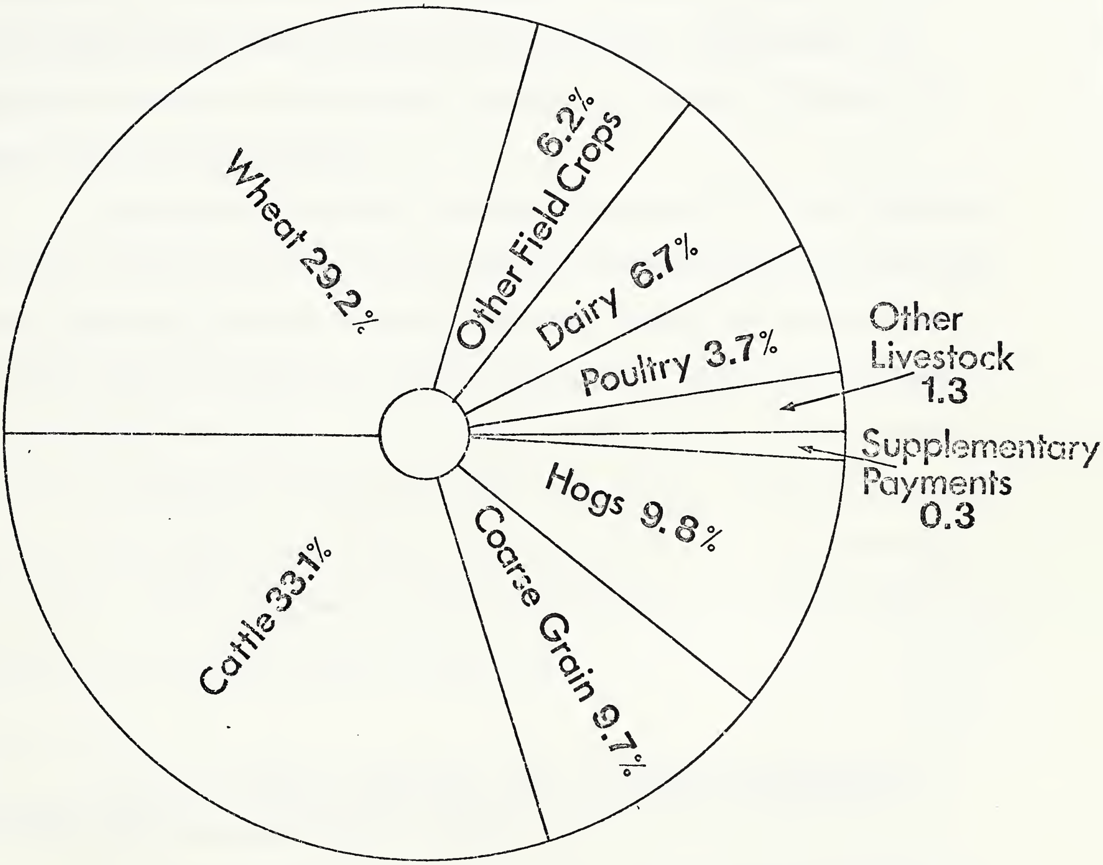
The importance of the hog industry is further emphasized by the fact that hogs accounted for from 10 to 12 percent of farmers' yearly

---

[1] Canada Department of Agriculture, Forty-ninth Annual Livestock Market Review (Ottawa: CDA, Markets Information Section, Production and Marketing Branch, 1969).

Figure 2-1

SOURCES OF FARM INCOME, 1968



Source: Alberta Department of Agriculture, Statistics of Agriculture for Alberta (Edmonton: ADA, 1968).

total cash receipts in the five years prior to and including 1967.[1] A slight decline in total farm cash receipts occurred in 1968, when 9.8 percent of farm income was supplied by hogs.[2] These figures reflect the magnitude of the hog industry in Alberta, for Canadian total farm cash receipts for hogs in 1967 and 1964 were 9.3 percent and 9.1 percent respectively. Furthermore, the hog industry consumes a sizeable proportion of feed grains grown in the western provinces; consequently, the industry contributes to the economic stability of western livestock producers and feed grain growers.

Although hog production and marketing occur in all ten provinces in Canada, these activities are not evenly distributed among the provinces. Of the producing provinces, Ontario, Manitoba, Quebec, and Alberta are the main areas of concentration in hog production. These four provinces together market 87.4 percent of all hogs slaughtered in inspected establishments in Canada.[3] Ontario, Manitoba, and Alberta, the three provinces on which this study focuses, market 68.3 percent of total hogs marketed in Canada.[4] Table 2-1 gives a provincial breakdown of commercial hog slaughter and estimated value of hogs sold.

---

[1] B. A. Hackett, Highlights 1967: Alberta Hog Enterprise Analysis (Edmonton: Alberta Department of Agriculture, Economics Division, Farm Management Branch, 1967).

[2] Alberta Department of Agriculture, Statistics of Agriculture for Alberta (Edmonton: ADA, 1967 and 1968).

[3] Inspected establishments include all packing plants and slaughterhouses inspected by federally employed graders.

[4] Canada Department of Agriculture, Forty-eighth Annual Livestock Market Review (Ottawa: CDA, Markets Information Section, Production and Marketing Branch, 1968).

Table 2-1

PERCENT OF COMMERCIAL HOG SLAUGHTER AND ESTIMATED VALUE OF HOGS SOLD BY MAJOR HOG PRODUCING PROVINCES, 1967-1968

Province	Hog Slaughter		Value of Hogs Sold	
	1967	1968	1967	1968
British Columbia	2.4	2.3	.5	.7
Alberta	19.2	20.8	17.7	19.6
Saskatchewan	6.3	6.3	7.0	7.1
Manitoba	12.2	12.0	9.2	9.3
Ontario	37.4	35.5	37.9	37.1
Quebec	18.7	19.1	24.1	22.5
Atlantic Provinces	3.8	4.0	3.6	3.7
Total	100.0	100.0	100.0	100.0

Source: Canada Department of Agriculture, Forty-Eighth Annual Livestock Market Review, p. 62.

The Edmonton, Winnipeg, and Toronto terminal markets were examined as representing hog marketing activities in the above mentioned provinces. A price differential analysis was performed on these spatially separated markets, and the results of this analysis were used in developing the short-run supply forecasting functions for the Alberta market. If the activities of the hog industry in the Alberta market are significantly explained, the results may, with major adjustments for environmental factors, be applicable to the hog industry throughout Canada.

Structure Prior to 1969

In Alberta in 1968, slaughter hogs moved to packing plants in a variety of ways involving several types of marketing agencies. The most important types of agencies included public stockyards, livestock

exchanges, commission firms, private shippers, shipping associations, truckers, and meat packing plants.[1] Producers had the alternative of marketing their hogs directly through terminal markets, direct to packing plants, or through commission firms who could in turn sell on the public yards or direct to plants.

Under this terminal market system, Edmonton, Calgary, and Lethbridge markets performed the function of reflecting the most current price for live hogs. The importance of this price reflecting function as performed by the terminals was emphasized by the report of the National Commission on Food Marketing:

> Terminal markets, in providing a central concentration point for many buyers and sellers to compete, perform another valuable function . . . that of pricing. Terminal market prices are reported by the Market News Service and are widely disseminated by communications media. Prices generated at terminal markets thus serve not only to transfer various grades and classes of livestock from seller to buyer at the terminal, but also guide the pricing of livestock elsewhere.[2]

Concern regarding the structure of the Alberta hog industry arose because of the terminals' failure to perform this function efficiently. Table 2-2 gives a breakdown of deliveries of hogs to yards and direct to packing plants by crop reporting districts. The percentage of hogs delivered direct to packing plants ranged anywhere from a low of 82.8 percent in crop district #6 (Calgary) to a high of 99.8 percent in crop district #8 (Red Deer, Lacombe). Figures show that for the 1968 calendar year only 4.4 percent of the live hogs marketed in the province

---

[1] Travis W. Manning, The Hog Marketing System in Alberta, Agricultural Economics Research Bulletin #4 (Edmonton: University of Alberta, July, 1967).

[2] Food From Farmer to Consumer, op. cit., p. 40.

Table 2-2

ALBERTA LIVE HOGS DELIVERED TO YARDS AND PLANTS BY CROP REPORTING DISTRICT, 1968

Crop District	Delivered to		Percentage Delivered to	
	Yards	Plants	Yards	Plants
1	499	12,145	3.9	96.1
2	14,688	108,605	11.9	88.1
3	4,599	32,817	12.3	87.7
4	180	5,571	3.1	96.9
5	8,877	61,944	12.5	87.5
6	22,601	108,898	17.2	82.8
7	335	98,073	.3	99.7
8	501	250,972	.2	99.8
9	--	--	--	--
10	3,357	256,794	1.3	98.7
11	12,584	294,309	4.1	95.9
12	1,487	104,546	1.4	98.6
13	3,790	201,192	1.8	98.2
14	329	3,771	8.0	92.0
15	1,269	82,219	1.5	98.5
1968 Total	75,096	1,621,856	4.4	95.6
1964 Total	94,975	1,459,389	6.1	93.9

Source: Canada Department of Agriculture, Forty-eighth Annual Livestock Market Review, p. 67.

were delivered to the public yards, as compared with 6.1 percent in 1964. For this reason, the industry became alarmed about the system of marketing hogs in the province.

The trend toward direct selling to packers had reached a critical point. In a study conducted in 1966-67, Manning pointed out that the three terminal hog markets in Alberta (Calgary, Lethbridge, and Edmonton) sold 8.8 percent of the hogs marketed in Alberta in 1965, a decline from the 9.3 percent sold in 1957.[1] Some 80,000 hogs, or less than 5 percent of the total number marketed, were sold at public auction in Calgary and Edmonton, and this small number established the base prices for most of the other hogs sold. The eight major packinghouses in Alberta purchased only 3 percent of their hog kill on the terminal markets; thus the base prices established for Alberta hogs reflected very little of the total demand by Alberta packers.

There were, of course, certain advantages in this system of acquiring hogs for the large producer who marketed a sizeable number of hogs. Packers introduced various means of awarding said producers, such as premium payments, quick payment, quick kill, subsidies on cattle, assembly and transportation cost subsidies, and other prearranged pricing formulas. The majority of hog producers in the province, however, did not have sufficient bargaining power to deal with an oligopolistic packinghouse industry. They had the alternative of dealing with truckers or assemblers who could deal with the packers, or they could accept the price as offered by packers for their direct shipments.

---

[1] Manning, op. cit., p. 9.

Concern over this supreme bargaining power held by the packers resulted in a concerted effort by producers in general to change the market structure of the Alberta hog industry. Talk of change within the industry dates back to the early 1960's. The next section in this chapter gives an historical development of the present hog marketing system as legislated under the Marketing of Agricultural Products Act, Government of the Province of Alberta, June, 1968.

Formation of the Alberta Hog Producers Marketing Board

With growing concern over the declining number of hogs being delivered to the terminal markets establishing the Alberta base price for the hog industry, various organizations directly related to the industry began moving to rectify the situation. The first such move was made jointly by the Farmers' Union of Alberta and the Alberta Federation of Agriculture who, in the fall of 1962, submitted a plan for the establishment of a Hog Marketing Board and called for an early plebiscite on the issue. It was later agreed by the Alberta Department of Agriculture and the organizations involved that such a vote should be postponed until after the results of a Saskatchewan plebiscite on a similar marketing structure had been released. Saskatchewan hog producers subsequently rejected a marketing board structure, but the Alberta organizations remained convinced that a marketing board was required in their province. Further action on a plebiscite was, however, postponed until after the Marketing of Agricultural Products Act underwent considerable revision in 1965.

In July of 1965, a Marketing Council was appointed under the new act, and shortly thereafter the Alberta Swine Council presented a

plan for the establishment of a commission authorized to assess all hogs marketed. These assessments were to be used mainly for research and product promotion in order to develop the swine industry in Alberta. Shortly after the Alberta Swine Council proposal had been received, the Alberta Livestock Cooperative gave notice that it intended to submit a plan calling for the establishment of a commission to voluntarily sell hogs utilizing teletype equipment. Consequently, the Marketing Council was faced with two proposals both calling for structural change in the hog marketing system. In the fall of 1965, the Council urged those organizations which had submitted plans to cooperate on a consolidated proposal acceptable to all members of the industry.

Such an attempt was made during the summer of 1966, but negotiations between opposing parties broke down. In December of 1966, the Marketing Council was notified that an agreement on consolidation was unlikely; hence, the Council assumed responsibility for devising a consolidated plan to be ratified by all segments of the industry. The Marketing Council's consolidated plan proposed the establishment of a commission for the buying and selling of hogs to be used by multiple selling agents. The Alberta Livestock Cooperative, the Alberta Federation of Agriculture, and the Farmers' Union of Alberta rejected this plan which did not call for the compulsory selling of slaughter hogs, thus further postponing a decision as to what plan Alberta should adopt.

Finally in November of 1967, five years after the first plan had been submitted, the Marketing Council advised all swine and farm organizations that the Minister of Agriculture had approved a proposal to obtain the opinions of hog producers concerning the type of marketing

they favored. Three basic plans were put to a vote. The organizations sponsoring these plans were the Western Hog Growers Association, the Alberta Livestock Cooperative, and a plan sponsored jointly by the Alberta Federation of Agriculture and the Farmers' Union of Alberta.[1]

The F.U.A./A.F.A. joint proposal called for the establishment of a Hog Marketing Board under which all hogs were to be sold through a single selling agency. The plan indicated that the Board would not have the power to establish marketing quotas. The Western Hog Growers plan called for the establishment of a Hog Merchandising and Development Authority. This too was a proposal for a Hog Marketing Board, but with the stipulation that the Board utilize multiple selling agencies. The synopsis of this plan states that "this is a plan in which you as a producer retain the right to sell your hogs through a competitive channel of your choice in a competitive and efficient market."

The third plan, submitted by the Alberta Livestock Cooperative, called for the establishment of an Alberta Swine Commission. Under this plan hogs were to be sold by a single selling agency that would be appointed by the Commission. Producers would, however, have the opportunity to opt out of the selling agency and sell direct to packers.

A plebiscite was held on the issue in the fall of 1968 following an extensive producer education program sponsored by the various organizations involved. The plan stipulated that if a minimum of 6,000 producers registered with the Marketing Council and these producers

---

[1] For a detailed description of the three marketing plans proposed for the Alberta hog industry see M. H. Hawkins, A. A. Warrack, and J. L. Dawson, Development and Operation of the Alberta Hog Producers Marketing Board, Agricultural Economics and Rural Sociology Bulletin 12 (General Information) (Edmonton: University of Alberta, April 12, 1971).

represented at least 600,000 slaughter hogs, a vote would be conducted. A simple majority of those who registered voting in favor of the plan would make it operational. There were 9,300 producers who registered to vote, of these, 7,432 actually cast ballots. The vote count showed 6,418 producers in favor of the F.U.A./A.F.A. proposal, 994 against, and 62 ballots spoiled. The results of the plebiscite indicated the wishes of Alberta hog producers--68.8 percent of all registered hog producers had voted for the now existing hog marketing board. Of the producers who voted, 87.7 percent cast ballots in favor of the establishment of a board; consequently, the provincial government began action to make the Alberta Hog Producers Marketing Board a reality.

Under the new marketing board structure, all hogs produced in Alberta and marketed within the province had to be sold through the Board's selling mechanism. Any producer or agent acting on his behalf could offer his hogs for sale F.O.B. any of the six designated shipping points in the province or any combination thereof. For example, a producer in the Red Deer area could offer his hogs F.O.B. Edmonton, Red Deer, or Calgary. In such a case the producer would be responsible for assembly and transportation costs to whichever point the hogs were bought. The other three areas designated as shipping points were Lethbridge, Lloydminster, and Grande Prairie. As a result, all hogs marketed in the province were open to competitive bidding by all packing plants in the province, as well as to export markets.[1]

---

[1] The charge by the Marketing Board as designated in the Hog Marketing Plan for performing the selling and other related functions was set at 30 cents per hog marketed. Of this 30 cents, 5 cents was set aside solely for market research and product promotion. The actual selling function utilizes the dutch-auction system with descending tapes being run through the machine at 5 cent incremental drops. The Board or any agent operating on its behalf has the power to withhold hogs from the market, but producers are obligated to deliver their hogs to the purchaser once they have notified the Board of their intentions to sell.

The function of assembling and transporting hogs has undergone a major change due to the revised market structure. Packer owned buying stations no longer handle hogs in the rural areas of Alberta. Several of the more strategically located assembly yards have been taken over by private trucking firms and assemblers, but the majority have ceased assembling hogs for further shipment.

The bulk of the analysis performed in this thesis pertains to the time period prior to the establishment of the Alberta Hog Producers Marketing Board. As stated earlier, however, a comparison is made between pricing patterns and information flows both prior to and following the change in market structure. Although the short-run supply function is developed on 1967-1968 delivery data, the function's forecasting ability is tested utilizing data generated by the Board since its inception. A study of the forecasting ability of the supply function is summarized with results in Chapter VI.

CHAPTER III

LITERATURE REVIEW

Hog prices and cycles have been the topic of numerous studies. The first section of this review deals with major studies on hog prices; the second section reviews studies concerned primarily with daily hog prices.

Major Studies

Regularly recurring cycles in hog prices were pointed out nearly a century ago by Bremner.[1] By 1913, Warren had expanded on this concept, concluding that the hog production cycle tended to be regular and noting the effect of an unusual U.S. corn crop in shifting the hog curve.[2]

Statistical methods in hog price analysis were first utilized by Wallace in 1920. His investigations centered on the relation of corn prices to future hog prices. Employing the multiple correlation technique, he performed studies on the relation of hog supplies and business activities to hog prices.[3]

The high degree of correlation between the wholesale and retail prices of hog products and the prices of live hogs was pointed out by

---

[1] S. Bremner, Bremner's Prophecies of Future Ups and Downs in Prices (16th ed.; Cincinnati: R. Clarke Co., 1907).

[2] G. F. Warren, Farm Management (New York: The MacMillan Co., 1913), p. 87.

[3] H. A. Wallace, Agricultural Prices (Des Moines: Wallace Publishing Co., 1920).

numerous investigators. Among those making prominent contributions in this area were Wallace,[1] Wentworth and Ellinger,[2] and Wright.[3]

Researchers and economists are continuing to analyze hog production, hog prices, and hog cycles in an attempt to clarify relationships among them.[4] Major refinements being made in this research include the utilization of quarterly or semiannual rather than annual data and the analysis of seasonal variations and other environmental characteristics once overlooked by research studies. Recent research utilizing these procedures includes Maki,[5] Kerr,[6] and Fuller and Ladd.[7] The most important study, however, was conducted by Harlow in 1961.[8] In a study utilizing

---

[1] *Ibid.*

[2] E. N. Wentworth and T. U. Ellinger, "The Determination of Hog Prices at Public Markets," *Journal of Farm Economics*, VI, No. 3 (July, 1924), pp. 279-282.

[3] S. Wright, *Corn and Hog Correlations*, U.S. Department of Agriculture Bulletin 1300 (Washington, D.C.: U.S. Government Printing Office, 1925).

[4] The historical sketch developed here is based on the review in Arthur A. Harlow, *Factors Affecting the Price and Supply of Hogs*, U.S. Department of Agriculture Technical Bulletin 1274 (Washington, D.C.: U.S. Government Printing Office, December, 1961), pp. 3-4.

[5] Wilbur R. Maki, "Forecasting Livestock Supplies and Prices with an Econometric Model," *Journal of Farm Economics*, XLV, No. 3 (August, 1963), pp. 612-625.

[6] T. C. Kerr, *Determinants of Regional Livestock Supply in Canada*, Publication No. 15 (Ottawa: Agricultural Economics Research Council of Canada, July, 1968).

[7] Wayne A. Fuller and George W. Ladd, "A Dynamic Quarterly Model of the Beef and Pork Economy," *Journal of Farm Economics*, XLIII, No. 4 (November, 1961), pp. 797-812.

[8] Harlow, *op. cit.*.

Ezekiel's cobweb theorem, which produced a four-year cycle,[1] Harlow discussed the principal economic forces affecting the hog economy and quantified these forces in a statistical model. The general equations for Harlow's cobweb model were:

$$S_t = a_1 + b_1 P_{t-1} + u_t$$

$$P_t = a_2 + b_2 D_t + v_t$$

$$S_t = D_t,$$

where S_t was the quantity supplied in period t, P_{t-1} the price in the previous period, P_t the price in period t, D_t the quantity demanded, a and b were estimated parameters, and u_t and v_t residual or error terms. Harlow proceeded to solve this recursive cobweb model and then used the model to forecast intermediate and long-run supply and demand of hogs in the U.S. economy.

Daily Studies

The current study approaches the problem of hog prices in a slightly different manner by analyzing the daily market and daily hog prices. The first known attempt at analyzing daily hog price movements was made by Stover in 1932.[2] Through the use of graphs and frequency tables, Stover pointed out the characteristics of daily price and supply variations and measured the response in supply to daily price fluctuations under varying conditions on the Chicago market. Shortly afterwards, Wells investigated briefly the relation between daily

---

[1] Mordecai Ezekiel, "The Cobweb Theorem," Quarterly Journal of Economics, Vol. 52, No. 2 (March, 1938), pp. 255-280.

[2] H. J. Stover, Relation of Daily Prices to the Marketing of Hogs at Chicago, Bulletin 534 (Ithaca, N.Y.: Cornell University Agricultural Experiment Station, January, 1932).

changes in prices and subsequent truck receipts at Sioux City.[1] They both found that price changes and subsequent receipt changes were positively correlated.

The North Central Livestock Marketing Research Committee discovered in 1948 that price differentials between markets tend to change from one day to the next.[2] They found, for example, that the difference in price between Chicago and St. Paul changed 73 percent of the time on a sample of 1,267 days.

The National Commission on Food Marketing devoted a section of their report to the analysis of weekly data and concluded that: (1) farm price changes and wholesale price changes moved together rather closely in time, while wholesale price changes and retail price changes were separated by a lag distributed over several weeks; and (2) factors other than price changes at one point in the marketing channel were also involved in explaining price changes at another point.[3]

One of the most comprehensive studies performed on the daily hog market in the United States was conducted by Leuthold at the University of Wisconsin.[4] Leuthold expanded the analysis of daily price

---

[1] O. V. Wells, Farmers' Response to Price in Hog Production and Marketing, U.S. Dept. of Agriculture Technical Bulletin 359 (Washington, D.C.: U.S. Government Printing Office, April, 1933).

[2] North Central Livestock Marketing Research Committee, Price Differentials for Slaughter Hogs, Bulletin P-39 (Ames, Iowa: Iowa Agricultural Experiment Station, August, 1948).

[3] Food from Farmer to Consumer, op. cit.

[4] Raymond Leuthold, "Economic Analysis of Daily Hog Price Fluctuations,"(unpublished Ph.D. thesis, University of Wisconsin, 1968).

movements by examining hog price patterns in the eight largest U.S. terminal hog markets. His study attempted to refine previous models of the hog economy, which used quarterly data by formalizing in an economic model the principal forces affecting the daily hog economy. The results he obtained were used to explain daily price and supply fluctuations and to predict daily prices and supplies for the terminal markets, both aggregated and individually.

This thesis relies on several of Leuthold's concepts and models. Numerous refinements and additions have been made to gear the models to the Canadian hog market. This study attempts to develop an economic model that will explain and predict daily hog prices and supplies in the Alberta market.

CHAPTER IV

DAILY HOG PRICE ANALYSIS

Because of the multilevel nature of the pork production process, the hog industry in Alberta is very complex. The marketing channel is composed of producers, marketing agencies, transportation agencies, meat processors, wholesale meat distributors, and retail firms, all of which play a vital role in the process of getting pork from the producer to the consumer. With such a diverse marketing channel, there are necessarily several prices corresponding to each level of production; that is, the price of dressed pork, the price of live hogs, the retail price, etc. This study focused only on the price of dressed weight hogs in Canada. The study was limited to dressed weight hog prices because this is the price producers receive; therefore, the dressed hog price becomes an integral part of the supply analysis performed in Chapter VI.

This chapter contains a discussion of how dressed weight hog prices were established and reported in 1967 and 1968. The characteristics of these prices over time and over space are investigated, along with the transmission of price information from one market to another.

Prices and Market Reports

Price Quotations

Hogs in Canada are produced primarily by farmers engaged in hog-farrow-finish enterprises or straight hog feeding enterprises. This suggests that some operations are concerned only with the production of feeder hogs and do none of their own feeding. The extent of

integration by packers and feed manufacturers into hog production is unknown. It is possible that some packers and feed manufacturers have financed the facilities and supplied feed on a contract basis, but evidence of such activity is based on conjecture. Because of lack of knowledge with respect to vertical integration, it was assumed that at the time of this study an insignificant number of hogs were being produced outside of farm operations.

Fed hogs are generally sold through the various marketing channels to packing plants for slaughter. Figure 4-1 illustrates the type of marketing channels available to the hog producer. The method of establishing the price of hogs varied according to the type of marketing system in existence. At the time of this study, both Manitoba and Ontario were operating Hog Marketing Boards. Under this type of system, the price of hogs was established competitively through an electronic bidding process. One major difference between the two systems was the opting out clause available to Manitoba Producers. As a result, producers could ship hogs either through the Board's selling mechanism or direct to packers, whereas Ontario producers could sell only through the mechanism of the Ontario Marketing Board.

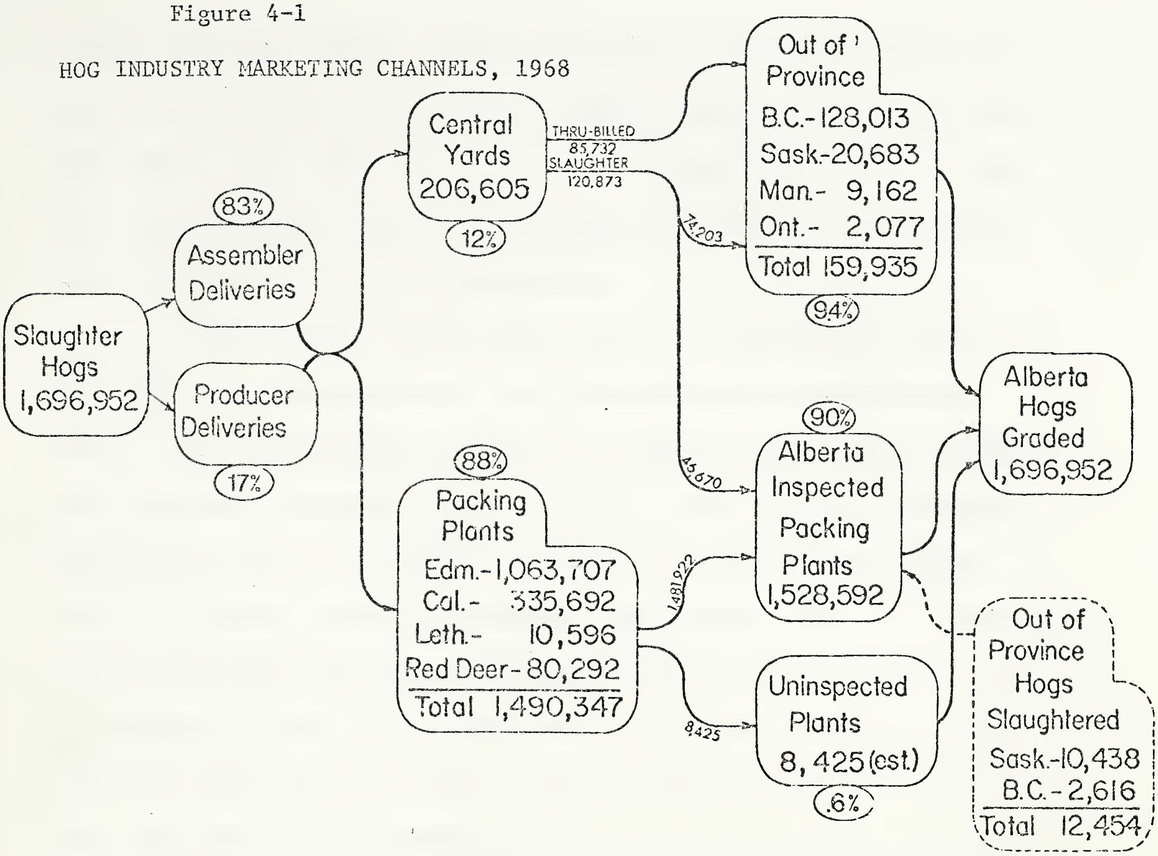
At the same time in Alberta, however, prices for hogs were being established through various processes. Approximately 5 percent of the total hogs marketed were shipped direct to public stockyards to be bid for competitively by the various packers and export buyers.[1] The other 95 percent were sent directly to packers or indirectly to packers

---

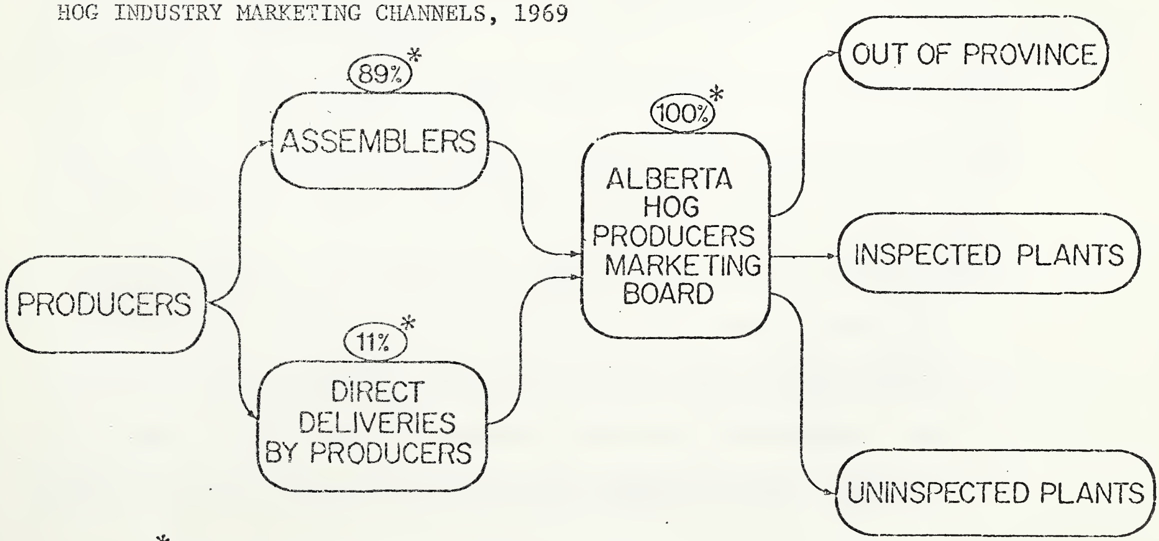
[1] Canada Department of Agriculture, Forty-eighth Annual Livestock Market Review, p. 67.

Figure 4-1

HOG INDUSTRY MARKETING CHANNELS, 1968



HOG INDUSTRY MARKETING CHANNELS, 1969



*Percentages are based on one month's marketings by the Board.

Source: James L. Dawson, Allan A. Warrack, and Murray H. Hawkins, Location Analysis for Alberta Hog Assembly Centers, Agricultural Economics and Rural Sociology Bulletin 11 (Technical Research) (Edmonton: University of Alberta, March, 1971).

through commission firms. Of this 95 percent, some hogs received the price as established at the terminal market; others received the weekly high price or some other price arrived at through bargaining. At the local level auctions and dealers generally set their own price levels based on reports of the terminal markets.

Under Canada's hog grading system, in effect until the end of 1968, hogs were graded basically on a dressed weight, conformation basis. The price of hogs was based on a dressed weight Grade A grading with deductions being made for Grade B and C hogs as well as for hogs weighing too much or too little. In 1969, a new hog grading system based on a weight, back-fat measurement was adopted. With the establishment of the Alberta Hog Producers Marketing Board and the beginning of its operation in the fall of 1969, all hogs sold in the province were sold at an index price of 100, the price established being the price of 100 index hogs. A price differential schedule which adjusted the final payment to the producer on the basis of whether the hog indexed better or worse than 100 was set up.

For the purposes of this study, the mean price of the price range quoted by both the Manitoba and the Ontario hog boards was taken as the established dressed weight hog price for that province. For comparison purposes the graphical analysis that follows was also performed using the high and the low prices of the range to test the accuracy of the assumption that the mean price was a true indicator of the actual dressed weight hog price in Manitoba and Ontario. For the Edmonton market the price quoted on the Edmonton public terminal

stockyards was taken as representative of prices received by all producers in the market area. This price quotation applied to only 5 percent of the hogs marketed in the Edmonton area;[1] however, the prices paid to producers for direct shipments to plants were indeterminable and must be assumed to correlate with the quoted dressed weight hog prices established at the public stockyards.

Price Reporting

The Market Information Services branch of the Canada Department of Agriculture was responsible for collecting, reporting, and disseminating market news across Canada in 1967 and 1968. The provision of this service aided in establishing a price at any given market by informing buyers and sellers of available supplies as well as opening and closing prices. Market Information Services also provided market participants with reliable information concerning trading activities in nearby markets by passing information from one market to another through various communications media. Price variations among markets were thereby reduced.

Reporting of information on the terminal markets was done by trained staff members located at each market. This information was considered quite accurate and reliable because the reports were based on observations of actual sales. Little information was gathered from localized markets, auction markets, dealers, etc., and the information that was gathered from these markets was not considered to be very accurate.

---

[1] Ibid.

Information Flows

Market Information Services relies mainly on Telex and telephone reports for relaying market information from one market to another. In order to understand the price information flows between markets, it is necessary to look at the opening times of the various markets and at the time market reports are issued and received by the various terminal markets under observation.

The Toronto market opens two hours before the Edmonton market and one hour before the Winnipeg market. When Ontario and Manitoba are on daylight saving time, there is still a one-hour opening time difference between Toronto and Winnipeg, and Edmonton opens three hours after Toronto and two hours after Winnipeg. The official market opening times suggest an east to west price information flow for hogs.

The schedule of reporting trading action in Toronto and Winnipeg similarly supports the east to west market information flow hypothesis. Both Winnipeg and Toronto telephone a hog market report to Edmonton in the late morning indicating various price changes and supplies on hand. In 1967 and 1968, the Edmonton hog market did not become active until early afternoon; that is, hogs delivered in the morning were generally held until early afternoon before active trade on hogs began. This being the case, market participants in Edmonton, and to some extent in Winnipeg, had a complete report on activities in the eastern markets at their disposal prior to active trading in their own market area.

Thus for the terminal markets under study, the western market in Edmonton received and had a chance to utilize within the same day

established prices transmitted from the two major eastern markets. Price information gathered at the western market was apparently transmitted too late for the eastern markets to use it extensively within the same day. Therefore, it was hypothesized that not only do western markets utilize price information generated from the eastern markets within the day, but eastern markets may only utilize price information transmitted from western markets on the previous day.

These conjectures will be investigated more closely later in this chapter. The price patterns established in each of the markets and their interrelationships among the markets will now be examined.

Terminal Market Prices

Graphical Presentation

In this section graphs of the daily prices established in the terminal markets were constructed to show how these prices behave over time. This gives the reader an historical picture of daily hog price movements and illustrates interesting similarities and differences among the markets. Graphs are also included showing price changes in each market rather than absolute price levels. The price changes plotted involve the calculation of first differences, thus expressing the change in price from day to day.

The data used for this analysis were the daily dressed weight hog prices for the 1967 and 1968 calendar years.[1] For the Edmonton terminal market, the price used was the price of dressed weight Grade A hogs at the Edmonton terminal stockyards. For the Winnipeg and Toronto

---

[1] The source of these prices was Market Information Services, Canada Department of Agriculture, Edmonton.

terminals the price used was threefold; namely, the high, mean, and low of the range of prices quoted for dressed weight Grade A hogs by the respective hog boards.

The two years of price data utilized in this analysis were broken into yearly time periods. Thus six graphs are included, three showing price trends in 1967 and three illustrating price movements in 1968. The graphs in Figures 4-2 through 4-7 were plotted using a computer plotter. Another two graphs showing price changes for the two years are also included as Figures 4-8 and 4-9.

In general, the most significant feature of the six graphs (Figures 4-2 through 4-7) is that in each graph prices tended to move together quite closely over time. This simultaneous up-and-down movement of the three markets suggests that the markets were aware of and utilized market knowledge in determining their hog prices.

A close inspection of Figure 4-2 shows that the fluctuation of prices in 1967 was very erratic. The graph does illustrate, however, that the price gaps tended to close somewhat during the last five months of the year. This pattern may also be observed in 1968, for Figure 4-3 shows that the price spread during the first six or seven months is greater between Toronto and Winnipeg than during the last five or six months. Both figures further indicate that the price in the Edmonton market does not fluctuate in quite the same pattern as it does in the other two markets. This observation can be tentatively explained by the type of price data gathered and reported in the Edmonton market area. Because of the small number of hogs being shipped to the public stockyards in Edmonton, a price was not always established for each

Figure 4-2

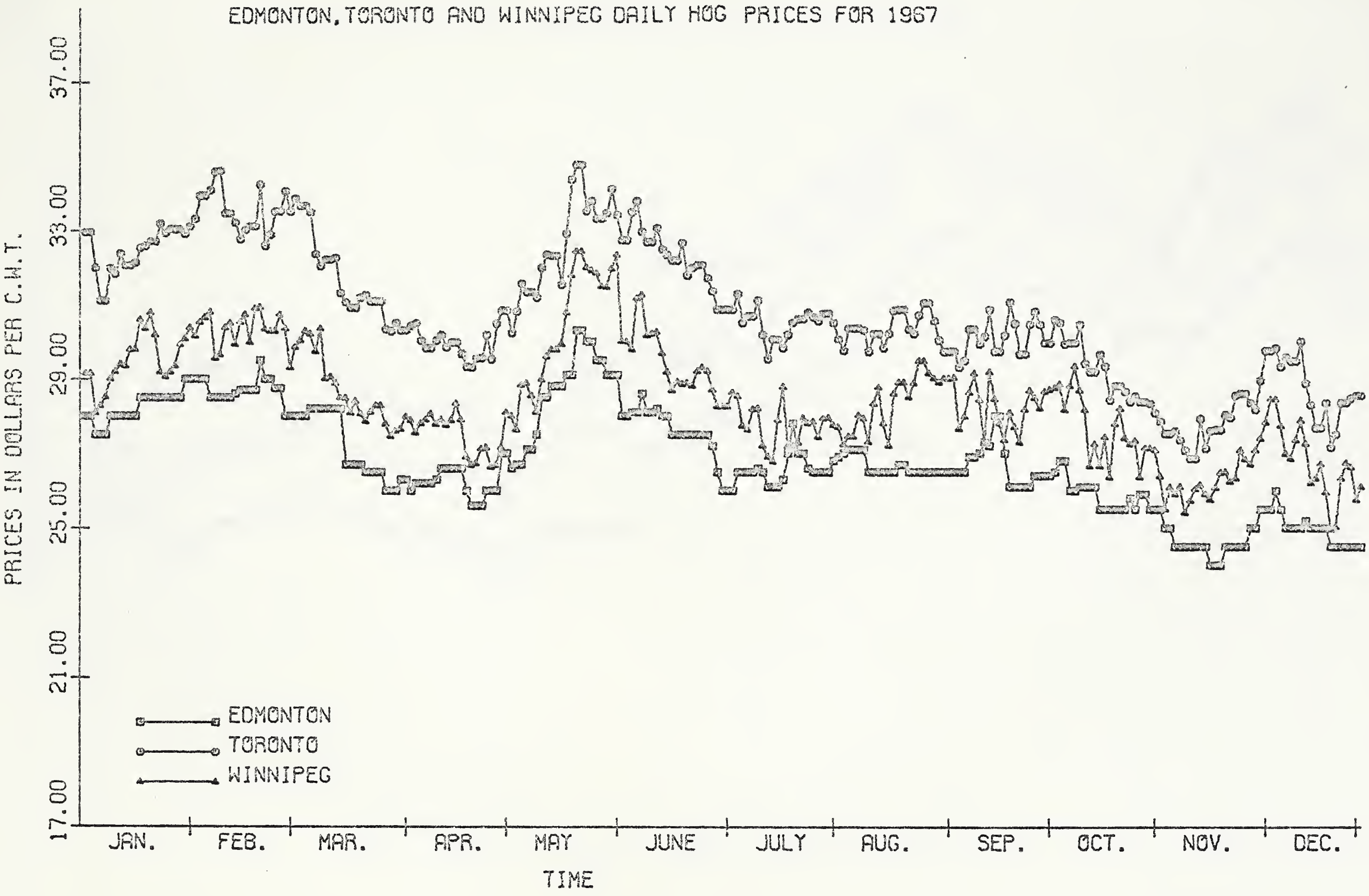
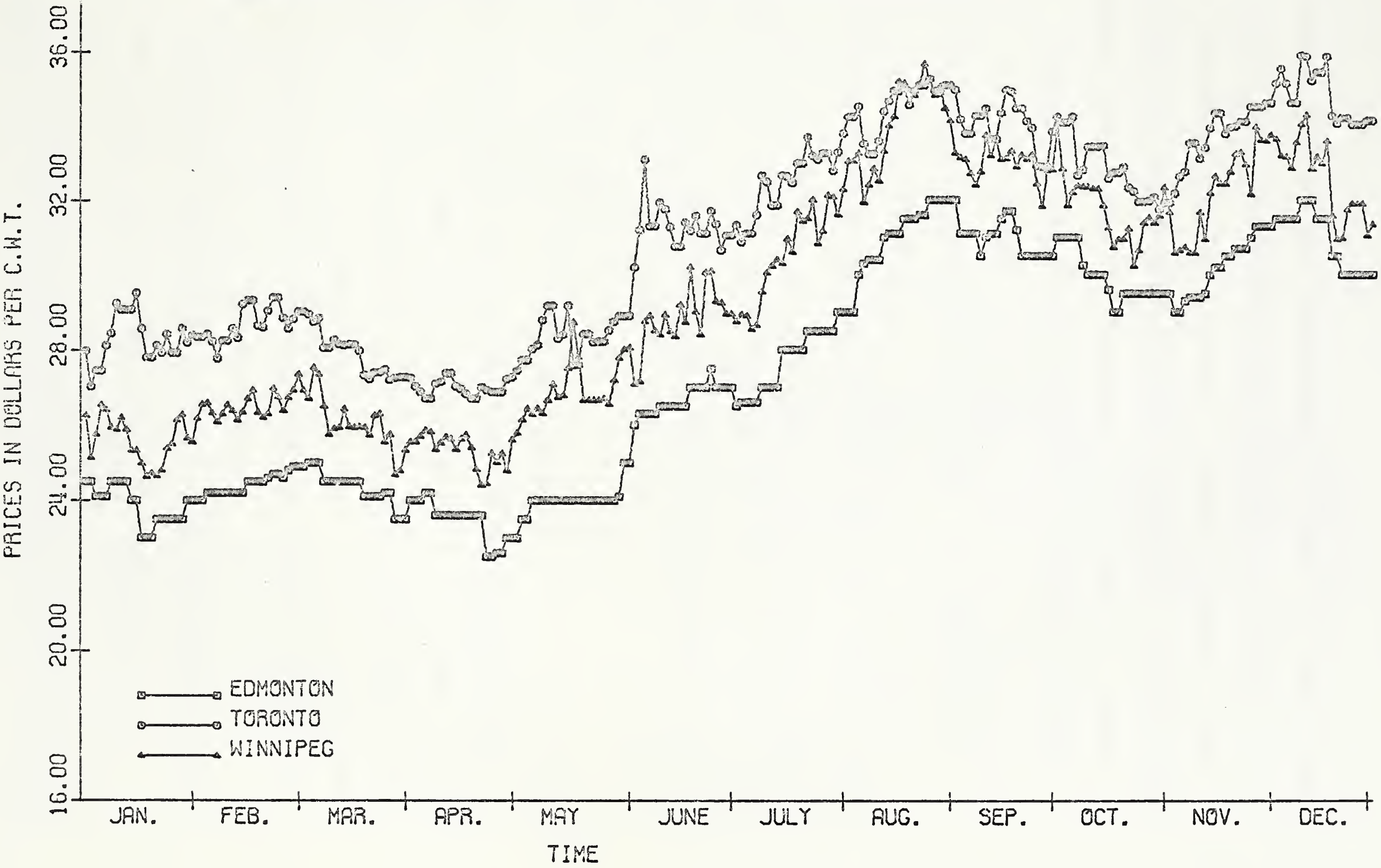

EDMONTON, TORONTO AND WINNIPEG DAILY HOG PRICES FOR 1967
PRICES IN DOLLARS PER C.W.T.
37.00
33.00
29.00
25.00
21.00
17.00
EDMONTON
TORONTO
WINNIPEG
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEP.
OCT.
NOV.
DEC.
TIME

Figure 4-3

EDMONTON, TORONTO AND WINNIPEG DAILY HOG PRICES FOR 1968



marketing day, in which case the previous day's price was taken as representative of the actual dressed weight hog price for that day. In actuality the exact fluctuation in price as paid to producers by the packing firms was indeterminable, and this fluctuation, if known, would likely more closely follow the fluctuations in the other two markets.

Figures 4-4 through 4-7 illustrate the movement of dressed weight hog prices for Toronto and Winnipeg in 1967 and 1968 using both the high and the low of the quoted price range. All graphs support the observation made with respect to Figures 4-2 and 4-3, namely, that the prices in Toronto and Winnipeg fluctuate quite closely in relation to each other whether the high, mean, or low of the price range is used. The spread in price using highs and lows once again suggests that the price difference between the two markets narrowed during the last half of 1967 and 1968 as compared to the price spread over the first six months of each year.[1]

The inclusion of Figures 4-4 through 4-7 served to test the assumption made earlier that the mean of the price range was a true indicator of dressed weight hog prices in Toronto and Winnipeg. Since the findings of the six graphs were very similar, the mean price of the price range quoted by the respective hog boards in Ontario and Manitoba was used as representative of dressed weight hog prices in Toronto and Winnipeg throughout the rest of the analysis.

Figures 4-8 and 4-9 plot the first differences among the three markets under study. From the graphs it may be observed that price

---

[1] A complete price differential analysis is performed later in the chapter to test the hypothesis that the price differential among the three stated markets is explained by the freight rates between the markets.

Figure 4-4

TORONTO AND WINNIPEG DAILY HIGHS 1967

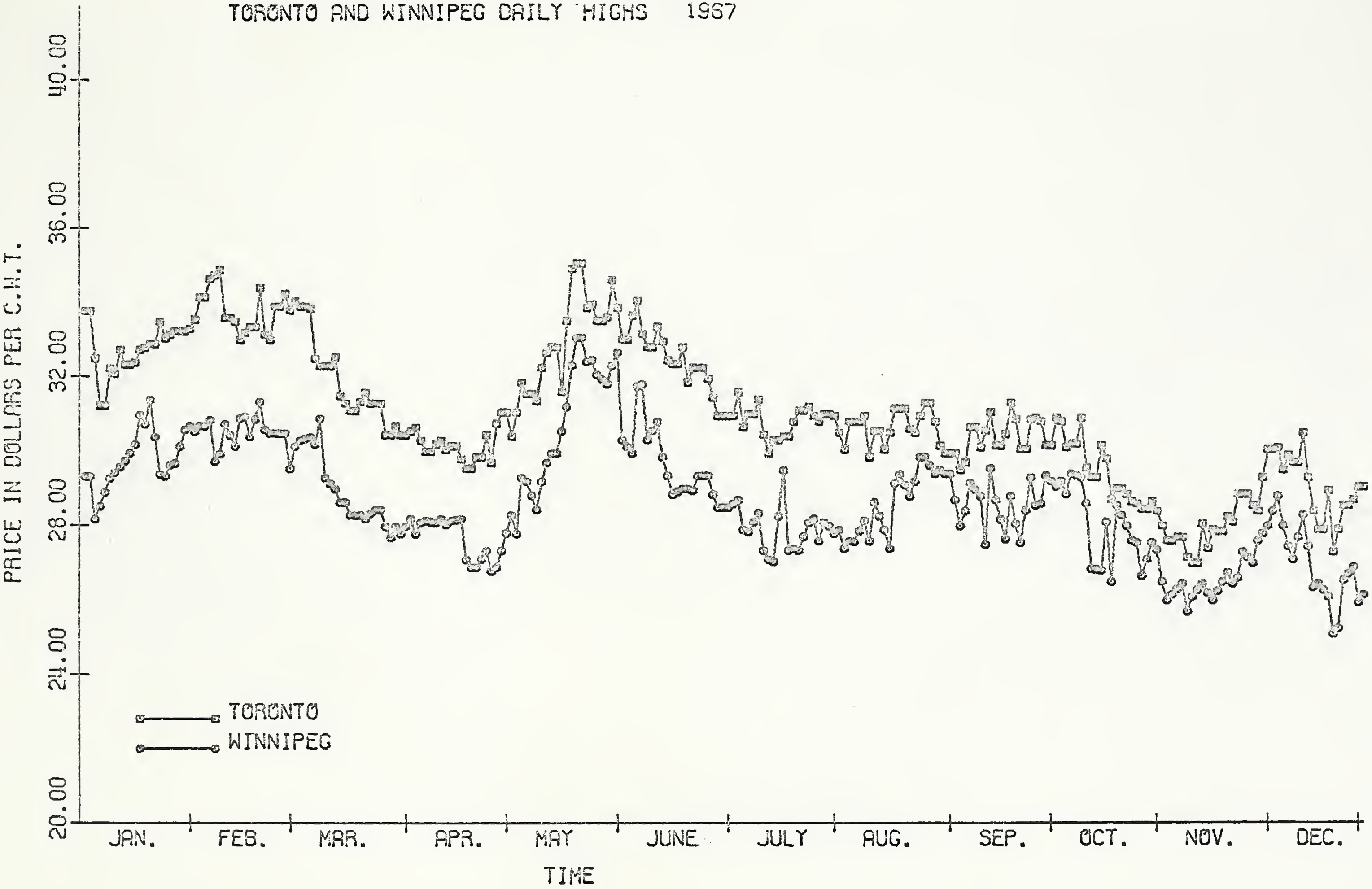


Figure 4-5

TORONTO AND WINNIPEG DAILY LOWS 1967

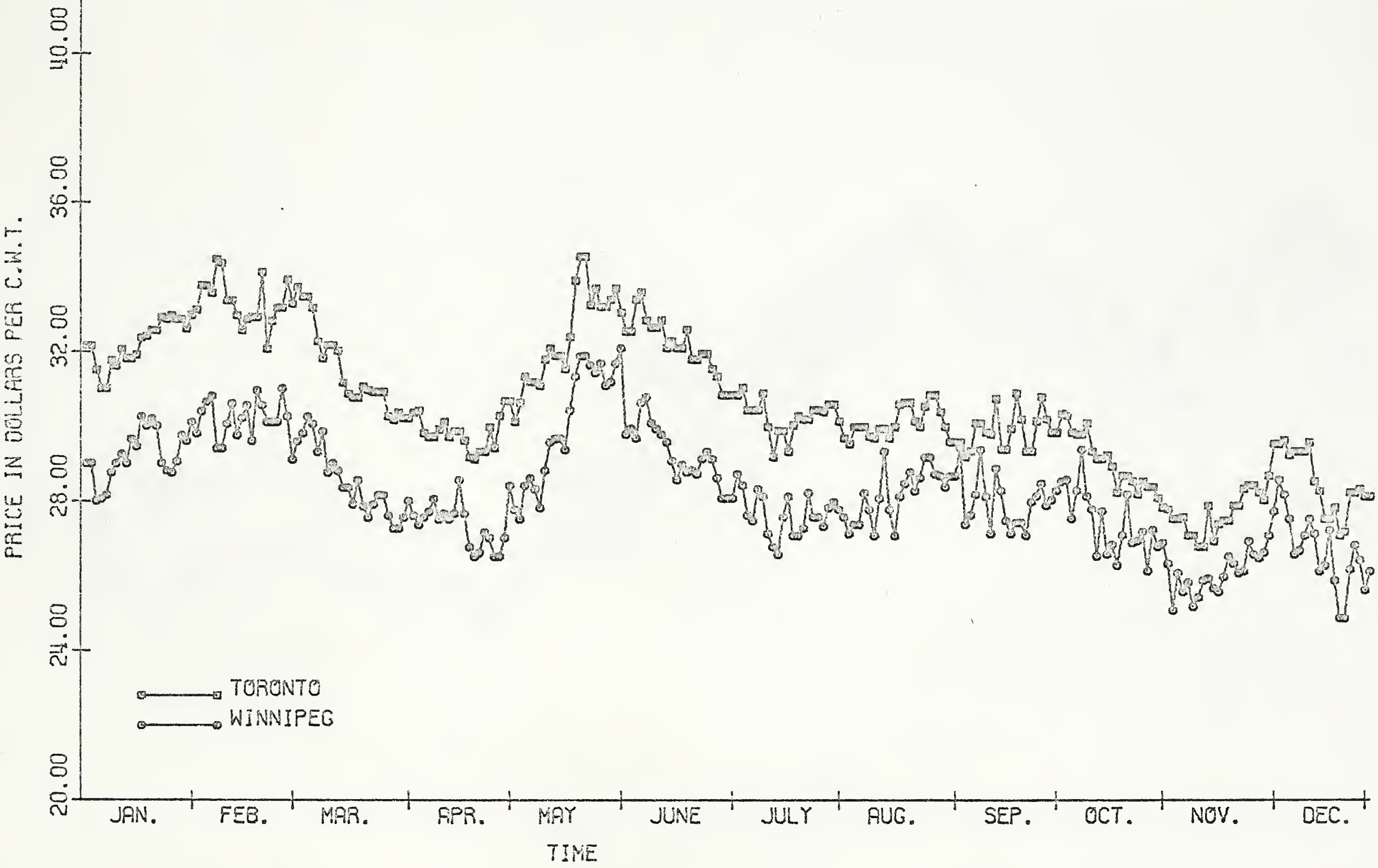
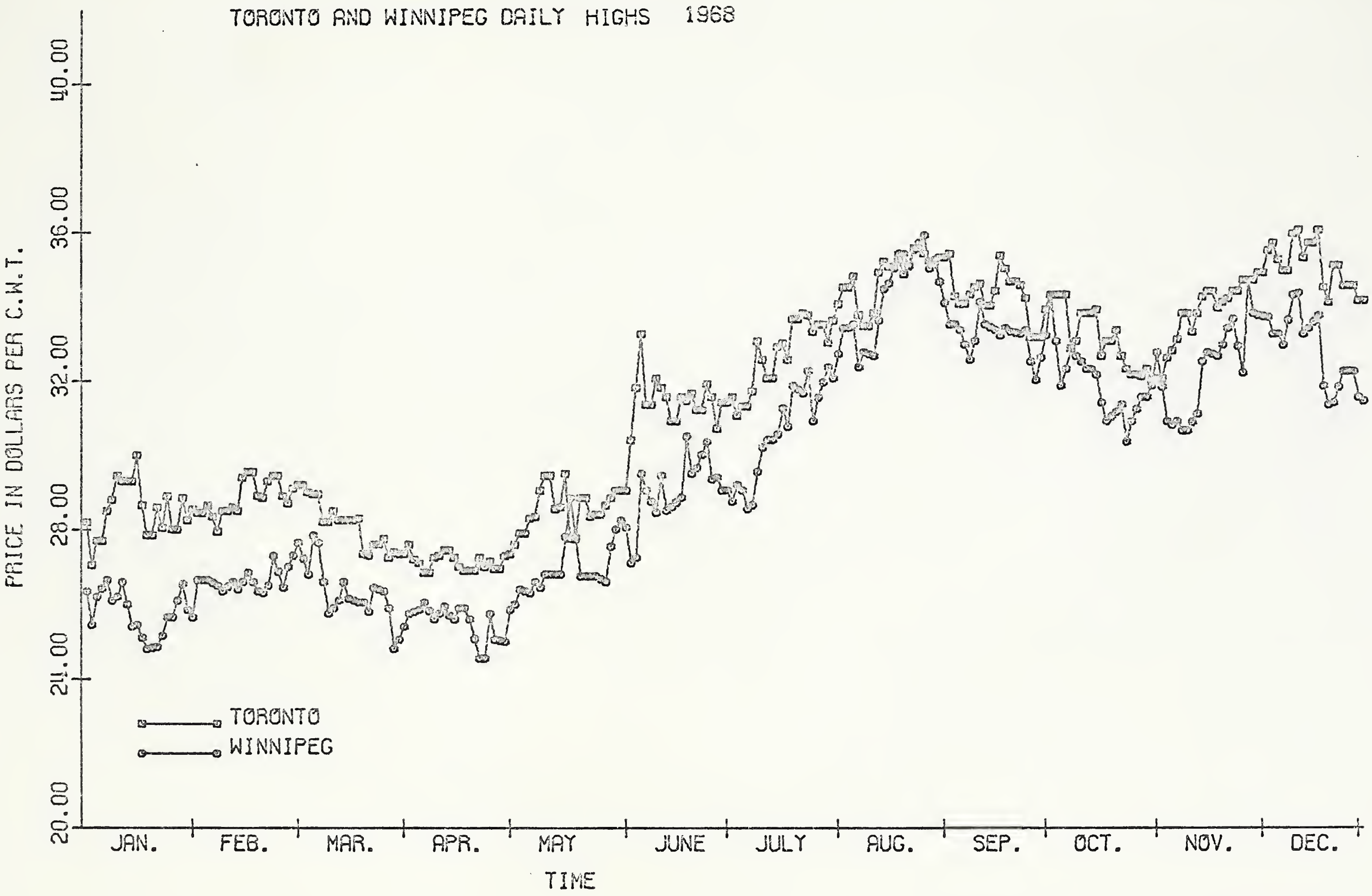


Figure 4-6



TORONTO AND WINNIPEG DAILY HIGHS 1968

Figure 4-7

TORONTO AND WINNIPEG DAILY LOWS 1968

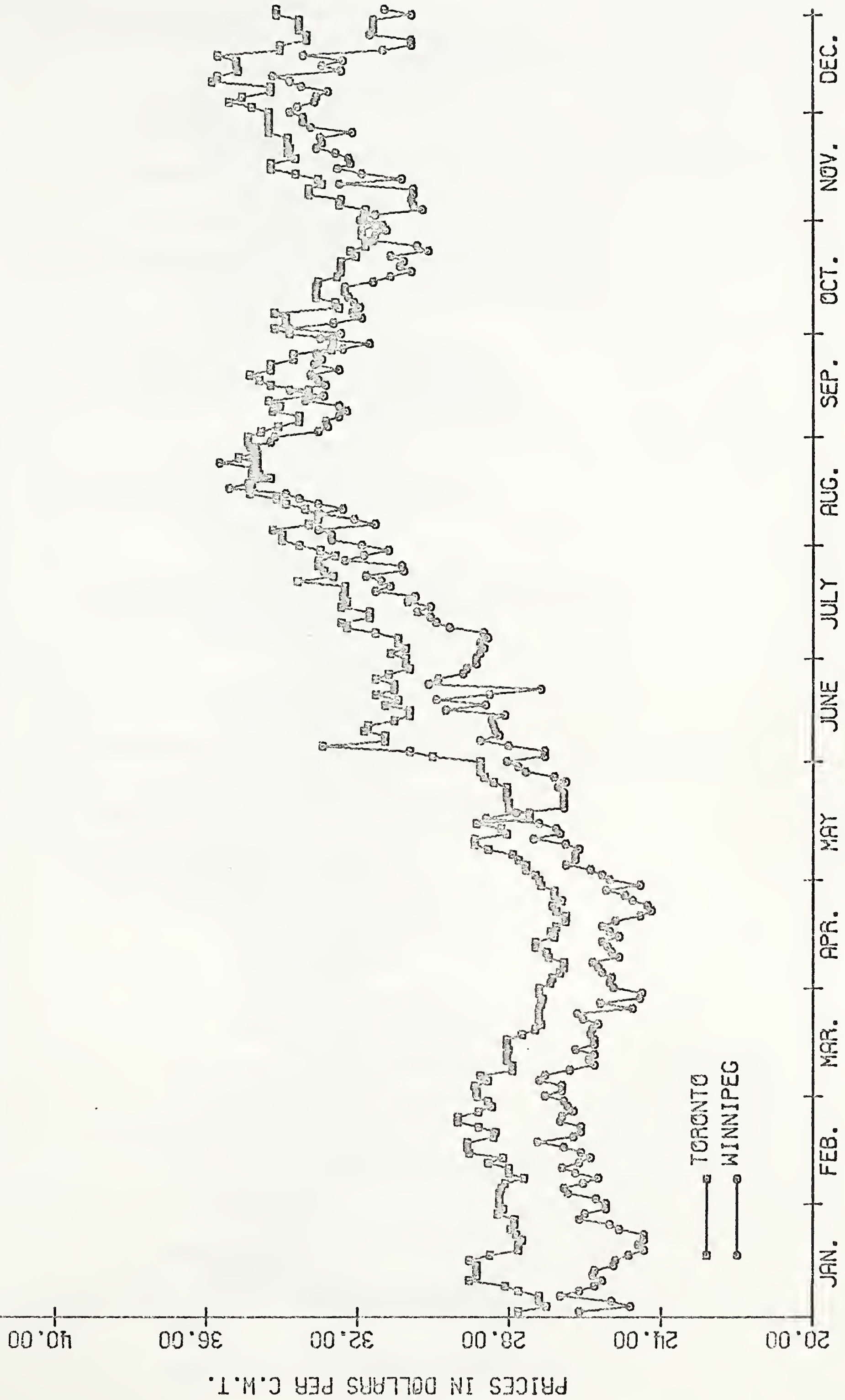
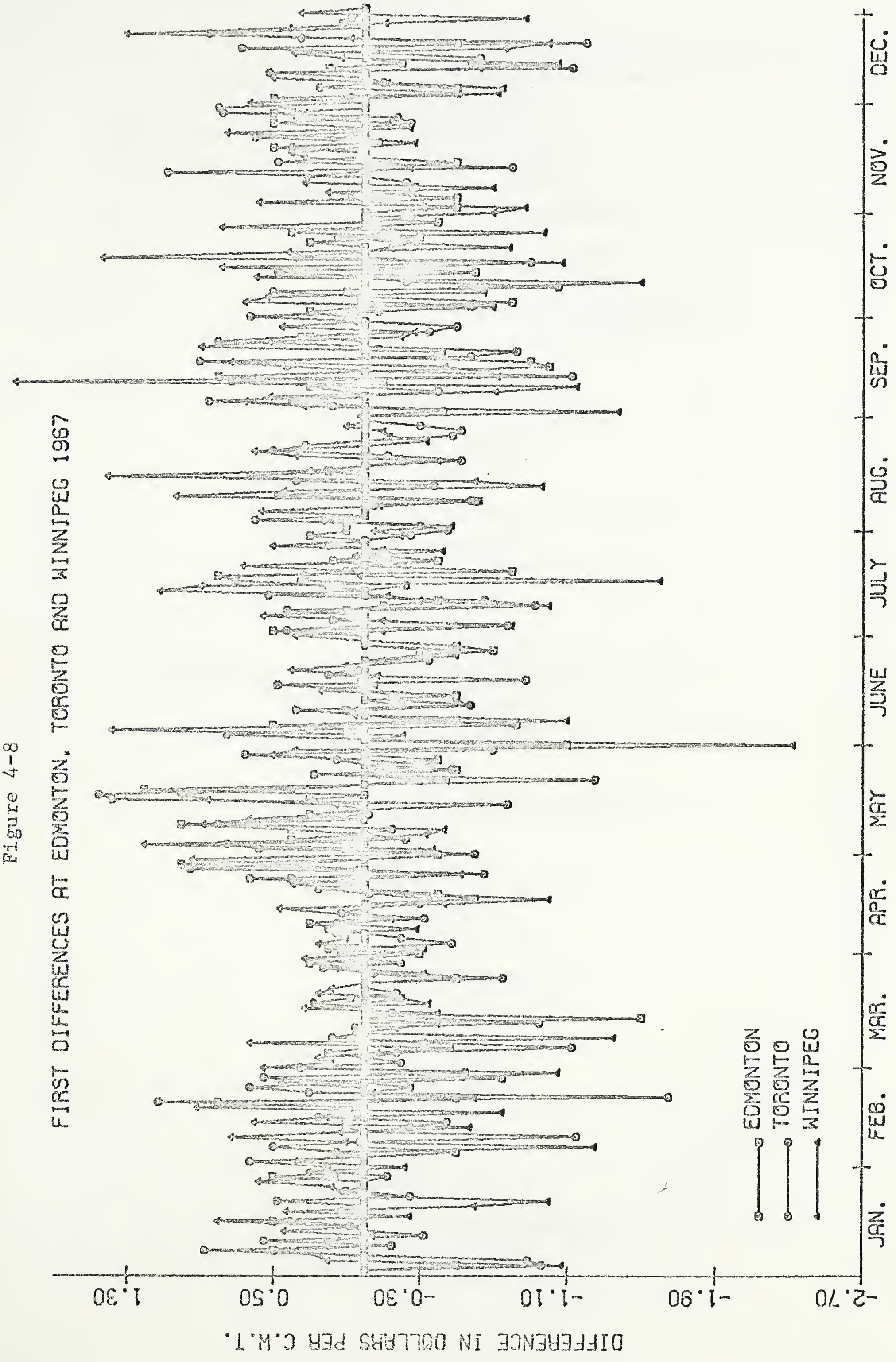


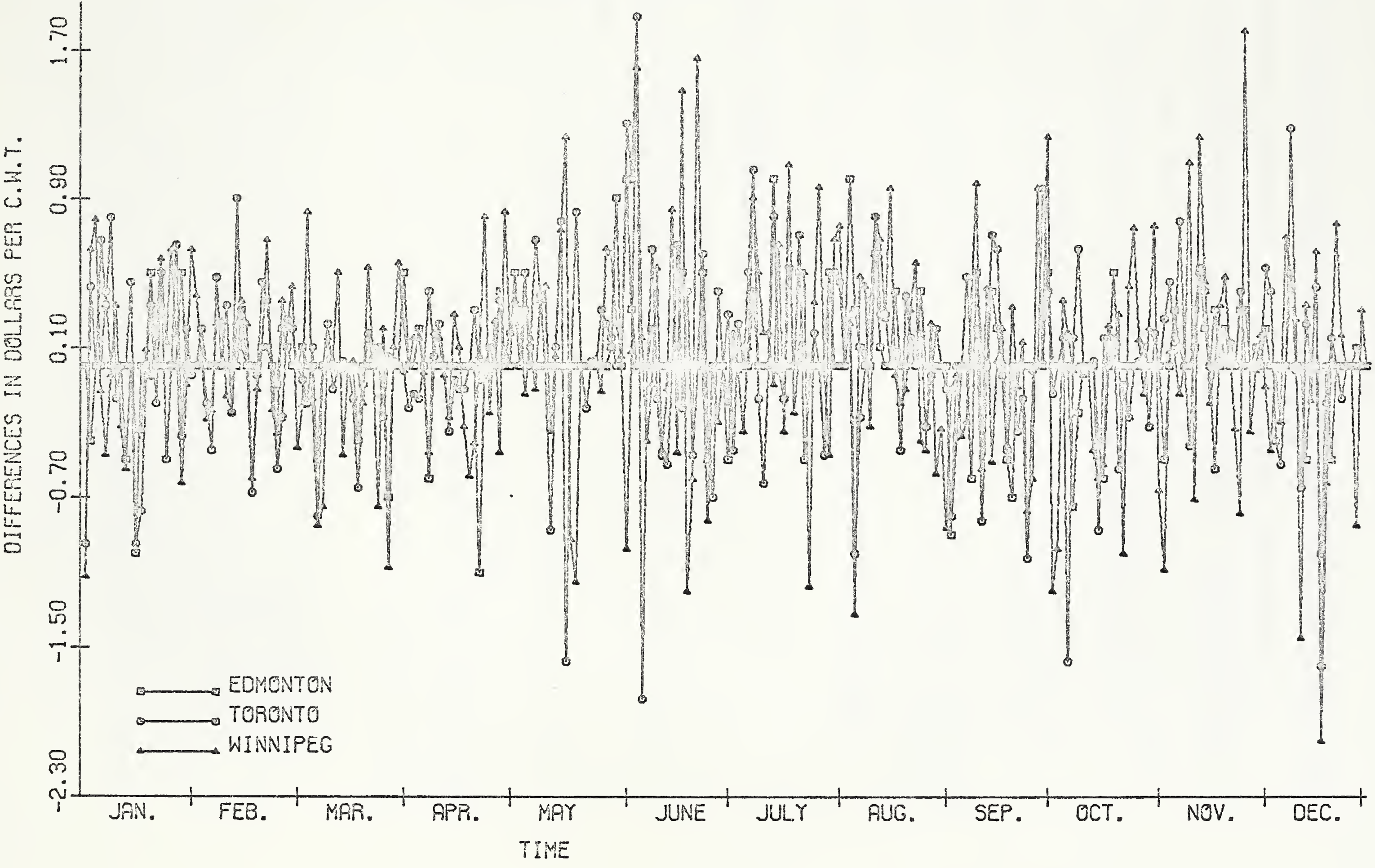
Figure 4-8



FIRST DIFFERENCES AT EDMONTON, TORONTO AND WINNIPEG 1967

Figure 4-9

FIRST DIFFERENCES AT EDMONTON, TORONTO AND WINNIPEG 1968



changes in the three markets do not follow any prescribed pattern. It was hypothesized that price changes in Winnipeg and Edmonton were determined by price changes in the Toronto market. Upon observation of Figures 4-8 and 4-9, however, this does not appear to be the case.[1]

The foregoing analysis illustrates graphically the price series for the three markets examined. All of the graphs show that the markets do tend to move together but that the exactness of the movements varies among markets. It is hypothesized that the differences in movements result from differing structures in each market, different market personnel, varying local demand and supply, and such other elements as weather.

Correlation Coefficients

The preceding section presented a graphical description of the price relations among terminal markets. This section focuses on developing a statistical description of the same relations through the use of correlation analysis. The procedure is to compute correlation coefficients between the daily prices and daily changes (first differences) in price for the three terminal markets under study. This yields a numerical summary statistic which indicates the degree to which

---

[1] Later in the chapter a correlation analysis is performed using first differences and various combinations of lagged first differences. The purpose of this analysis will be to test statistically the observations made with respect to price changes in the markets. The results of this analysis should substantially support the hypothesis that daily price changes among the three markets are not used by market participants in establishing their prices for dressed weight hogs but that absolute price levels are used in the markets in the establishment of individual market prices for hogs.

two market prices are related.[1] Table 4-1 summarizes these coefficients using data for the entire two-year period.[2]

The coefficients in Table 4-1 range between 0.12 and 0.29 with all the coefficients significant at the 99 percent level of confidence. Corresponding correlation coefficients for absolute prices range from 0.93 to 0.95, once again with all coefficients significant at the 99 percent level of confidence. High correlation coefficients between price changes in the two markets would indicate a relatively high degree of correlation while smaller coefficients would indicate a lesser degree of correlation. None of the correlation coefficients

---

[1] For a further description of a correlation coefficient see John E. Freund and Frank J. Williams, Modern Business Statistics (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1963), pp. 307-319.

[2] One of the reasons for computing correlation coefficients between first differences of prices as well as absolute price levels is to look at price changes from one day to the next as well as the price level for a particular day. Another reason is illustrated in the following example:

Using the same data as is used throughout this chapter, correlation coefficients resulting from actual daily prices for the three selected markets are:

	Winnipeg	Toronto
Edmonton	0.95	0.94
Winnipeg		0.93

The coefficients for the same three markets resulting from first differences of daily prices are:

	Winnipeg	Toronto
Edmonton	0.12	0.20
Winnipeg		0.29

As can readily be seen, relationships between markets can be distinguished more effectively using correlations of first differences rather than of actual prices. This same situation is true with respect to the lagged correlation coefficients which are presented later. When the lag is introduced, coefficients resulting from actual daily prices are still greater than 0.90.

in Table 4-1 using first differences of prices indicate a high or even a moderate correlation of price changes. In fact, the coefficients show a low correlation between price changes in the three markets. Toronto and Winnipeg give a 0.29 coefficient, which although the highest of the three is still very low. Winnipeg and Edmonton show a 0.12 coefficient between unlagged first differences suggesting that little or no relationship exists between price changes in the two markets.

Table 4-1

CORRELATION COEFFICIENTS OF DAILY PRICE LEVELS AND PRICE CHANGES FOR THREE TERMINAL MARKETS WITH EACH MARKET IN TIME t, 1967 - 1968

	Edmonton	Winnipeg	Toronto
Edmonton		0.12	0.20
Winnipeg	(0.95)*		0.29
Toronto	(0.94)*	(0.93)*	

* Values bracketed give correlation coefficients of absolute daily prices.

The coefficients of first differences in price in Table 4-1 indicate a varying but low degree of relationship among price changes on the terminal markets. The highest correlation exists between the Toronto and Winnipeg terminals, which have similar opening times and market structures. Both Toronto and Winnipeg have their lowest correlation with Edmonton, 0.20 and 0.12 respectively. This suggests that the price changes between those markets examined were not regular.

A similar first difference correlation analysis was performed using average weekly prices of the three terminal markets under study. The correlation coefficients of this analysis ranged between 0.50 and 0.60 which indicated that the markets responded more to price changes on a weekly basis than on a daily basis. These results similarly indicated that price information and its utilization by the various markets was not instantaneous but contained a lag factor which was not identified statistically in this study.

Another result using absolute price levels is that the degree of variation in coefficients is less than that for first differences. In this instance the coefficients are 0.93, 0.94, and 0.95, making comparisons of the degree of relationship between markets very difficult. The fact remains, however, that there is an overall high correlation between absolute price levels among the three markets.

The correlation coefficients presented in Table 4-1 do not give a complete picture of causal relationships, nor do they indicate whether price information flows from east to west or vice versa, except for the fact that some initial direction may be inferred from the different opening times of the markets. In order to better analyze daily price movements and describe possible information flows, correlation coefficients are computed for the same markets, but with one or more of the markets lagged one or more days. These coefficients can be compared to the coefficients presented in Table 4-1 to see how much prices move together within the day versus the previous day or days. The purpose of performing this lagged analysis is to aid in tracing the patterns of information flows.

Examination of Table 4-2 shows that the introduction of various combinations of lags has little effect upon the correlation of price changes among the three markets. None of the coefficients of lagged first differences exceeds any of the coefficients of unlagged first differences. In many cases the introduction of a one or more day lag results in a negative correlation coefficient. Consequently, the hypothesis that Edmonton and Winnipeg follow the Toronto market in pricing their hogs is not proved statistically. Similarly, the hypothesis that the Toronto base price for hogs is affected by the previous day's Edmonton price change is not statistically supported.

Another implication of the lack of correlation between lagged first differences concerns the hypothesized price information flows. The high correlation of absolute price levels among the three markets suggests that price information is transmitted and utilized within the markets. The low coefficients of lagged correlation do not, however, explain whether the flow of information is east to west or vice versa.

Price Differences Over Space

The previous graphical analysis indicates that the Toronto market has consistently higher prices than the other two markets; this section analyzes this feature more closely. Table 4-3 illustrates the average daily price differences between each terminal market and the three-market average during 1967 and 1968.

Table 4-4 provides the same information as Table 4-3, but in more detail. It is to be read as "the price of Grade A dressed weight hogs in market i is on the average Pij dollars higher than the price in market j."

Table 4-2

CORRELATION COEFFICIENTS OF DAILY PRICE CHANGES FOR THREE TERMINAL MARKETS
WITH ONE MARKET LAGGED ONE, TWO, AND THREE DAYS, 1967-1968

	Edmonton t	Winnipeg t	Toronto t	Edmonton t-1	Winnipeg t-1	Toronto t-1	Edmonton t-2	Winnipeg t-2	Toronto t-2	Edmonton t-3	Winnipeg t-3	Toronto t-3
Edmonton t	1.00	0.12	0.20	-0.33	0.01	0.00	0.05	0.00	-0.00	0.02	0.03	0.10
Winnipeg t	0.12	1.00	0.29	0.09	-0.14	-0.03	0.08	-0.22	-0.12	-0.00	-0.08	0.05
Toronto t	0.20	0.29	1.00	0.08	0.18	-0.03	-0.07	-0.10	-0.18	0.06	-0.15	-0.12
Edmonton t-1	-0.33	0.09	0.08	1.00	0.12	0.20	-0.33	0.01	0.00	0.05	0.00	0.00
Winnipeg t-1	0.01	-0.14	0.18	0.12	1.00	0.29	0.09	-0.14	-0.03	0.08	-0.22	-0.12
Toronto t-1	0.00	-0.03	-0.03	0.20	0.29	1.00	0.08	0.18	-0.03	-0.07	-0.10	-0.18
Edmonton t-2	0.05	0.08	-0.07	-0.33	0.09	0.08	1.00	0.12	0.20	-0.33	0.01	0.00
Winnipeg t-2	0.00	-0.22	-0.10	0.01	-0.14	0.18	0.12	1.00	0.29	0.09	-0.14	-0.03
Toronto t-2	-0.00	-0.12	-0.18	0.00	-0.03	-0.03	0.20	0.29	1.00	0.08	0.18	-0.03
Edmonton t-3	0.02	-0.00	0.06	0.05	0.08	-0.07	-0.33	0.09	0.08	1.00	0.12	0.20
Winnipeg t-3	0.03	-0.08	-0.15	0.00	-0.22	-0.10	0.01	-0.14	0.18	0.12	1.00	0.29
Toronto t-3	0.10	0.05	-0.12	0.00	-0.12	-0.18	0.00	-0.03	-0.03	0.20	0.29	1.00

Table 4-3

AVERAGE DAILY PRICE DIFFERENCE OF GRADE A DRESSED WEIGHT HOGS IN DOLLARS PER HUNDREDWEIGHT FROM THREE-MARKET AVERAGE, 1967-1968

Market	Price Difference
Toronto	+$1.98
Three-Market Average	Base
Winnipeg	-$0.06
Edmonton	-$1.91

Table 4-4

AVERAGE DAILY PRICE DIFFERENCE OF GRADE A DRESSED WEIGHT HOGS IN DOLLARS PER HUNDREDWEIGHT BETWEEN EACH OF THE THREE TERMINAL MARKETS, 1967-1968

j i	Winnipeg	Edmonton
Toronto	2.04	3.89
Winnipeg		1.85

Tables 4-3 and 4-4 show that considerable price differences exist among the markets. The greatest difference exists between the eastern market in Toronto and the western market in Edmonton. Differences similarly occur between Toronto and Winnipeg ($2.04 per hundredweight) and Winnipeg and Edmonton ($1.85 per hundredweight). Of the three markets examined, Toronto exhibits the highest average price, Edmonton, the lowest average price. For the western markets there appears to be some relationship between the price difference from Toronto and the market's distance from Toronto.

Intermarket Price Spreads Examined

One possible explanation for the higher prices in Toronto, apart from the geographical distance between markets, is that Toronto is closer to the great population centers of the St. Lawrence valley, a deficit food production area. Prices could be expected to be higher in this market area than in markets located closer to surplus hog producing regions. Such an explanation rests on the assumption that the hog industry in Canada is national rather than regional in its pricing behavior. If so, supply and demand on a national scale would interlock pricing relationships for hogs across Canada and would support the price differentials among markets as they presently exist. There are opinions, however, that hog production and marketing are regionally based in Canada; therefore, the validity of the above explanation may be open to question.

Another possible explanation for intermarket price spreads focuses on differences in average weight of slaughter hogs among markets. Table 4-5 gives the average weight of Grade A slaughter hogs in each of the markets for 1967 and 1968.

Table 4-5

YEARLY AVERAGE WEIGHTS OF GRADE A DRESSED WEIGHT HOGS
FOR THREE TERMINAL MARKETS, 1967-1968

Market	Average Weight, 1967	Average Weight, 1968
	pounds	
Toronto	156.2	159.1
Winnipeg	153.6	153.7
Edmonton	154.8	152.9

Table 4-5 indicates that the Toronto market has heavier hogs on the average than the two western markets and that Edmonton marketed lighter hogs in 1968 than the other two markets. The difference in average dressed weights between the markets, however, was not large enough or over a long enough period of time in order to observe if there was a trend developing in the data. Consequently, no conclusive results exist that would suggest a definite relationship between market weights and dressed hog prices among the three markets.

Price Differential Analysis

In the introductory chapter of this thesis, an hypothesis was made that differences in dressed weight hog prices as quoted on the three terminal markets examined were reflected solely by the freight rate differentials among these spatially separated markets. The prices used in testing this hypothesis were modified slightly from those used in the previous analysis. It was felt that a weekly average price rather than daily prices would better represent the intermarket price spreads. Also, weekly average prices covering the time period 1962-1970 were readily available at the University of Alberta, and it was felt that nine years of weekly data would give a better indication of price differentials than two years of daily prices.

Figures 4-10, 4-11, and 4-12 illustrate graphically the price differentials among the three markets from 1962-1970. In all three cases no significant trends appear to have developed over time. Although the intermarket price spreads fluctuate somewhat, they appear to follow a two to two and a half year cycle. From Figure 4-11, the Winnipeg-Edmonton intermarket price spread declines in 1962 and part of 1963,

Figure 4-10

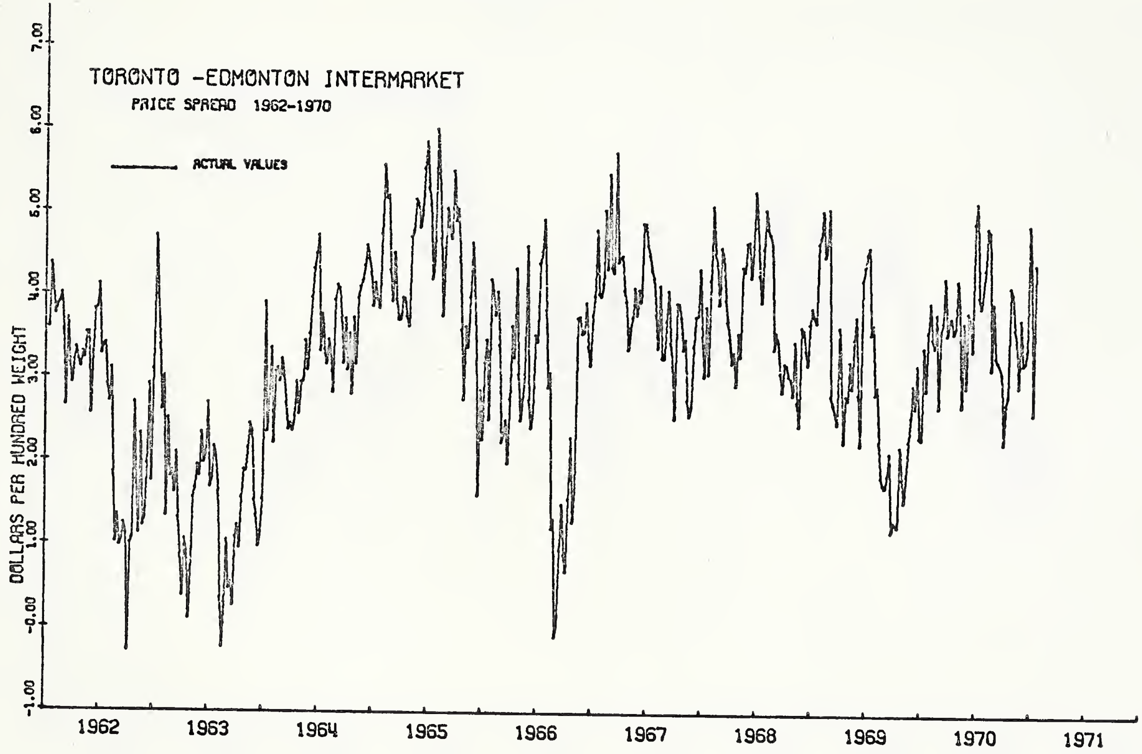

TORONTO -EDMONTON INTERMARKET
PRICE SPREAD 1962-1970
ACTUAL VALUES
DOLLARS PER HUNDRED WEIGHT
7.00
6.00
5.00
4.00
3.00
2.00
1.00
-0.00
-1.00
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971

Figure 4-11

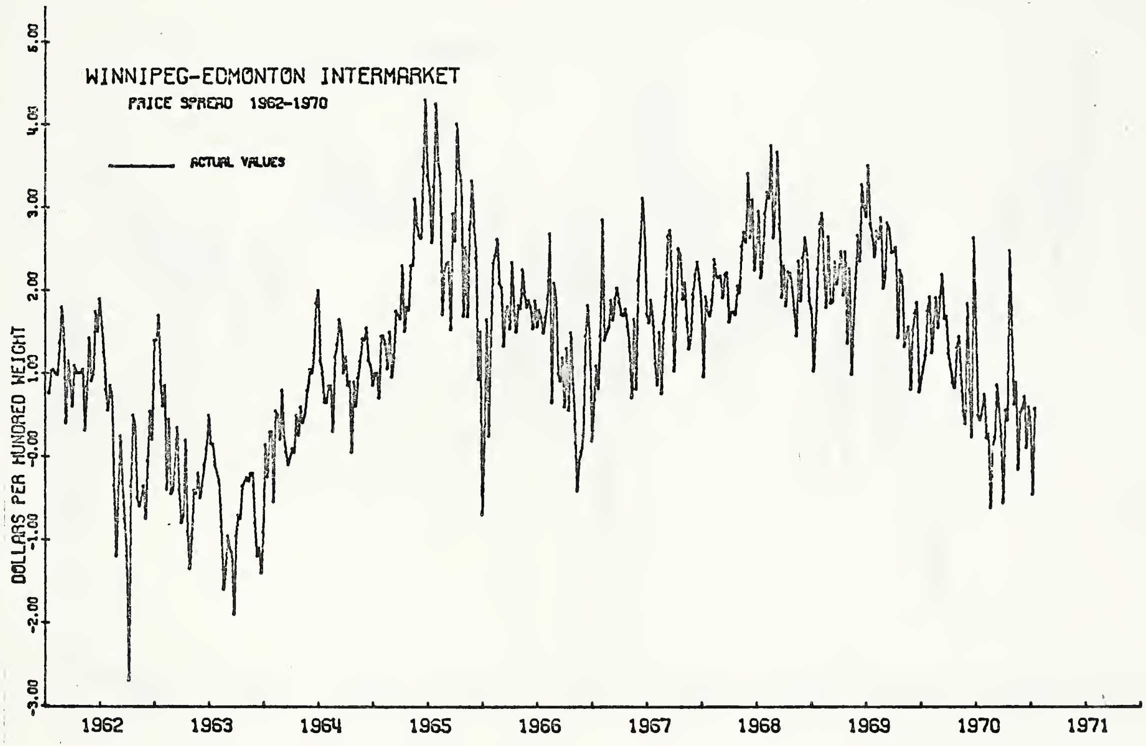
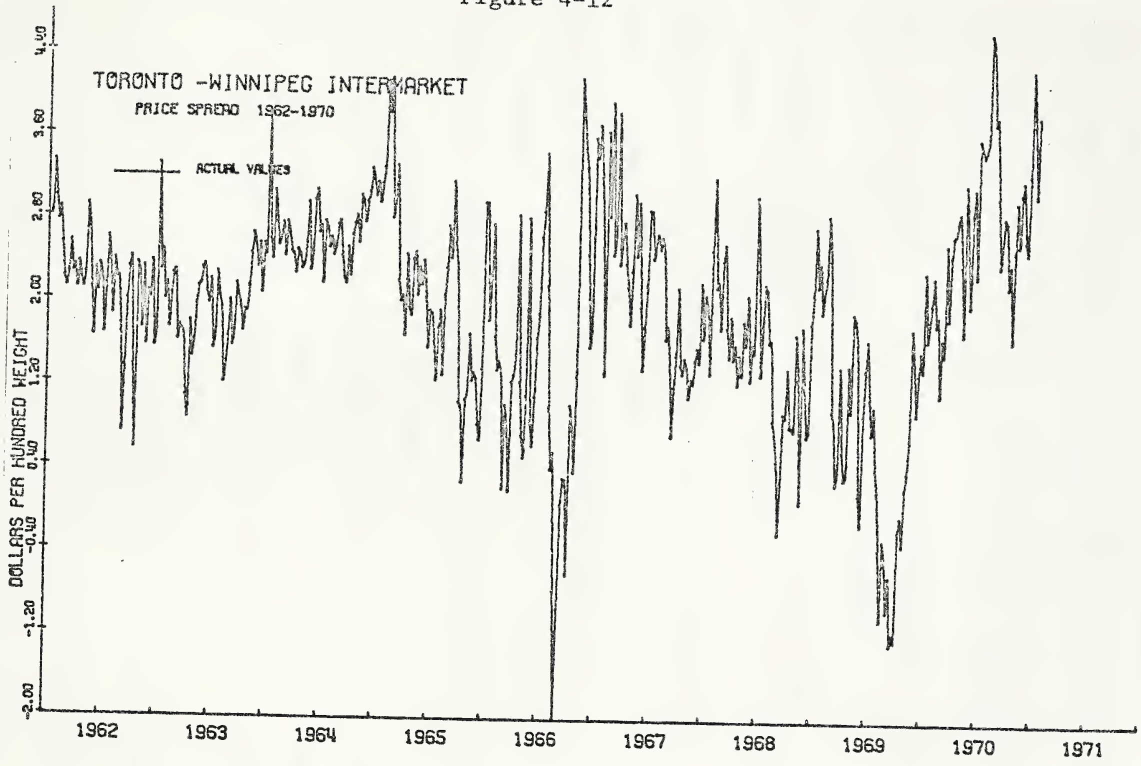

WINNIPEG-EDMONTON INTERMARKET
PRICE SPREAD 1962-1970
ACTUAL VALUES
DOLLARS PER HUNDRED WEIGHT
5.00
4.00
3.00
2.00
1.00
-0.00
-1.00
-2.00
-3.00
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971

Figure 4-12


TORONTO -WINNIPEG INTERMARKET
PRICE SPREAD 1962-1970
ACTUAL VALUES
DOLLARS PER HUNDRED WEIGHT
4.40
3.60
2.80
2.00
1.20
0.40
-0.40
-1.20
-2.00
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971

increases until mid-1965, then reverses and declines until early 1967 when it once again swings upward, and so on. Figures 4-10 and 4-12 appear to support this cyclical variation in price spreads.

Figure 4-10 illustrates the Toronto price minus the Edmonton price, that is, the price differential between Toronto and Edmonton dressed weight hog prices. This graph shows that the difference in price between the two markets fluctuates continuously, but generally remains between two and five dollars per hundredweight. As the freight rate between Edmonton and Toronto was $3.40 per hundredweight in 1968, Figure 4-10 suggests that geographical distance between the markets played a significant role in determining the price differential between the two markets. Judging from the wide and erratic fluctuations of the price differences, however, it is evident that freight rate was not the only factor affecting the price spread between the two markets.

Figures 4-11 and 4-12 illustrate the price differentials between Winnipeg and Edmonton and Winnipeg and Toronto respectively. Once again it may be noted that the price spreads follow the general freight rate structure with a certain degree of observed fluctuation. The actual freight rates between Edmonton and Winnipeg and Winnipeg and Toronto for 1968 were $1.75 and $2.20 per hundredweight respectively. Generally speaking, the price fluctuations were not extreme enough to rule out the possibility that price spreads were basically reflected by the freight rates among the three observed markets.

Statistical Verification

To test statistically the validity of the stated hypothesis,[1] the following statistical method was employed. The procedure was to take

---

[1] Subsidiary hypothesis #1, Chapter 1, p. 4.

the difference of the means of each market's two-year price series (1967 and 1968) and see whether this difference was significantly different from the observed freight rate differential. If the test showed that the difference of means was significantly different from the freight rate, the hypothesis would be rejected. If, however, the difference of means was not significantly different from the freight rate differential, the hypothesis could not be rejected. The standard t-test was used to test the significance of the freight rates in explaining intermarket price spreads.

The following table supplies the information required in testing the proposed hypothesis:

Table 4-6

STATISTICAL SUMMARY

Observed Markets	Difference of Means	Standard Error	t Statistic	t-test Statistic	Freight Rate
Edmonton-Toronto	$3.89	0.051	9.6	±1.65	$3.40
Edmonton-Winnipeg	$1.85	0.050	4.0	±1.65	$1.65
Winnipeg-Toronto	$2.04	0.057	2.8	±1.65	$2.20

The Null Hypothesis H_0 can be stated as follows: The mean of intermarket price spreads is equal to the freight rate between markets. Therefore, the Alternate Hypothesis H_1 reads: The mean of intermarket price spreads is not equal to the freight rate between markets. Symbolically the two hypotheses can be written as follows:

$$H_0 : \beta_g = k, \text{ and}$$

$$H_1 : \beta_g \neq k.$$

where β_g is the mean of intermarket price spreads for each market combination and k is the corresponding freight rate differential between these markets. The sample t-test statistic was calculated from the following equation:

$$t_s = \frac{\beta_g - k}{\sigma\beta_g} ,$$

where β_g and k were the same as earlier defined and $\sigma\beta_g$ was the standard error of the mean intermarket price spread. The critical t-values in the above table were calculated from a two-tail t-test table and illustrate the boundaries of the critical region in the test. The critical t-values were calculated at the 99 percent level of confidence.

The results indicate that the sample t-statistic does not lie between the boundaries of the critical region. Consequently, the Null Hypothesis $H_0 : (\beta_g = k)$ was rejected at the 99 percent level of confidence. In other words, it may be stated that the mean of intermarket price spreads was significantly different from the freight rate differential for the three markets in 1967-1968. This finding positively supports the results of the correlation analysis performed on the three markets earlier in this chapter. It appears that there was no pricing interaction among the hog markets and since the freight rates do not totally account for the price spreads, this further suggests that the three hog markets operate independently of one another and that they should be treated as regional markets rather than segments of an overall national market.

The next section of this chapter continues with the overall price analysis by comparing the pricing relationships over time and space and by contrasting information flows among markets developed in this chapter with those developed since the foundation of the Alberta Hog Producers Marketing Board.

Daily Hog Price Relationships, 1969-1970

As outlined in Chapter 1, one of the purposes of this study was to compare price relationships over time and over space as they existed prior to the establishment of the Alberta Hog Producers Marketing Board to price relationships as they presently exist under the marketing board structure. This section of the chapter outlines the pricing patterns now existing in Alberta and draws comparisons to results presented earlier in the chapter.

Price Quotations and Reporting

A major change has taken place in the method of gathering and reporting market information with respect to hogs in Alberta. Under the hog marketing board structure, all hogs produced in the province for slaughter are sold through the marketing board's electronic selling machines. All packers and export buyers in the province have an opportunity to bid upon all hogs offered for slaughter, and the price of each sale is relayed to each buyer in the province at the time of sale. Consequently, the within province method of distributing market information has been greatly enhanced by the establishment of a single selling agency within the province.

The method of gathering and reporting out-of-province hog sales and prices has remained relatively unchanged since 1967 and 1968. Likewise, daily and weekly summaries of hog sales and prices in Alberta are still reported by newspapers, television, and radio, all of which carry the closing summaries on a daily and weekly basis.

Terminal Market Prices

A graphical illustration of absolute daily hog prices in 1969-1970 appears in Figure 4-13. This graph shows the tendency of hog prices in Edmonton, Winnipeg, and Toronto to move quite closely in relation to each other. It also illustrates that when prices were extremely high in the latter months of 1969 and the early months of 1970, prices in the three markets were very close to one another, but as prices began to fall in March of 1970, Edmonton and Winnipeg prices fell relatively faster than Toronto prices, producing a noticeably larger price spread than was the case when prices were high or in 1967-1968.

The probable reason for this occurrence is that Alberta and Manitoba are generally net exporters of hogs and hog products. When the hog supply rapidly increased in the spring of 1970, the export possibilities of these two provinces became even greater; consequently, their prices became more responsive to market prices for hogs in the United States. Ontario, on the other hand, is generally self-sufficient in the production of hogs; therefore, its prices were not as responsive to the increased hog supply as were those on the Winnipeg and Edmonton markets.

Figure 4-14 plots the first differences in prices in the three terminal markets under study. As was the case in 1967 and 1968, no

Figure 4-13

EDMONTON, TORONTO AND WINNIPEG DAILY HOG PRICES FOR 1969/70

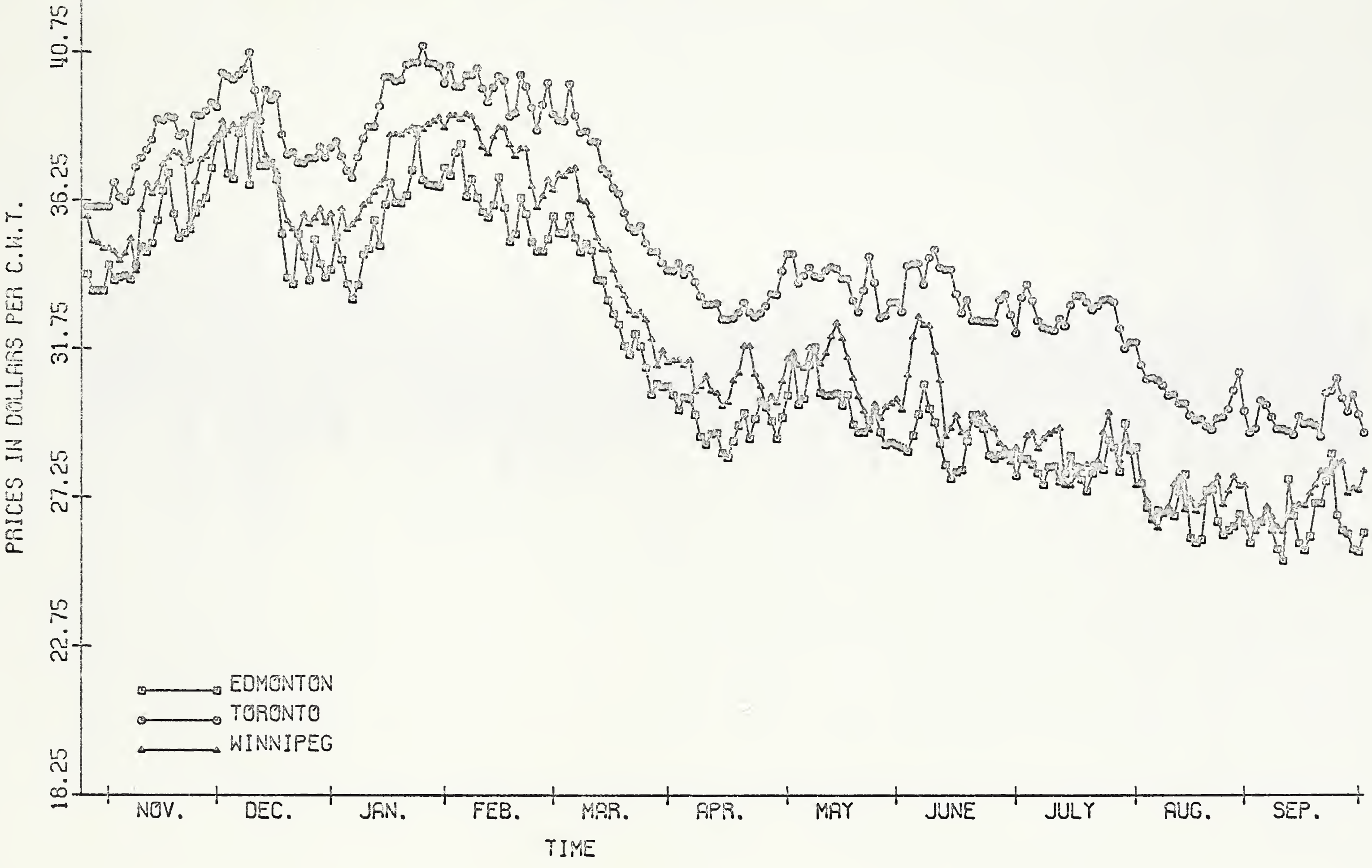
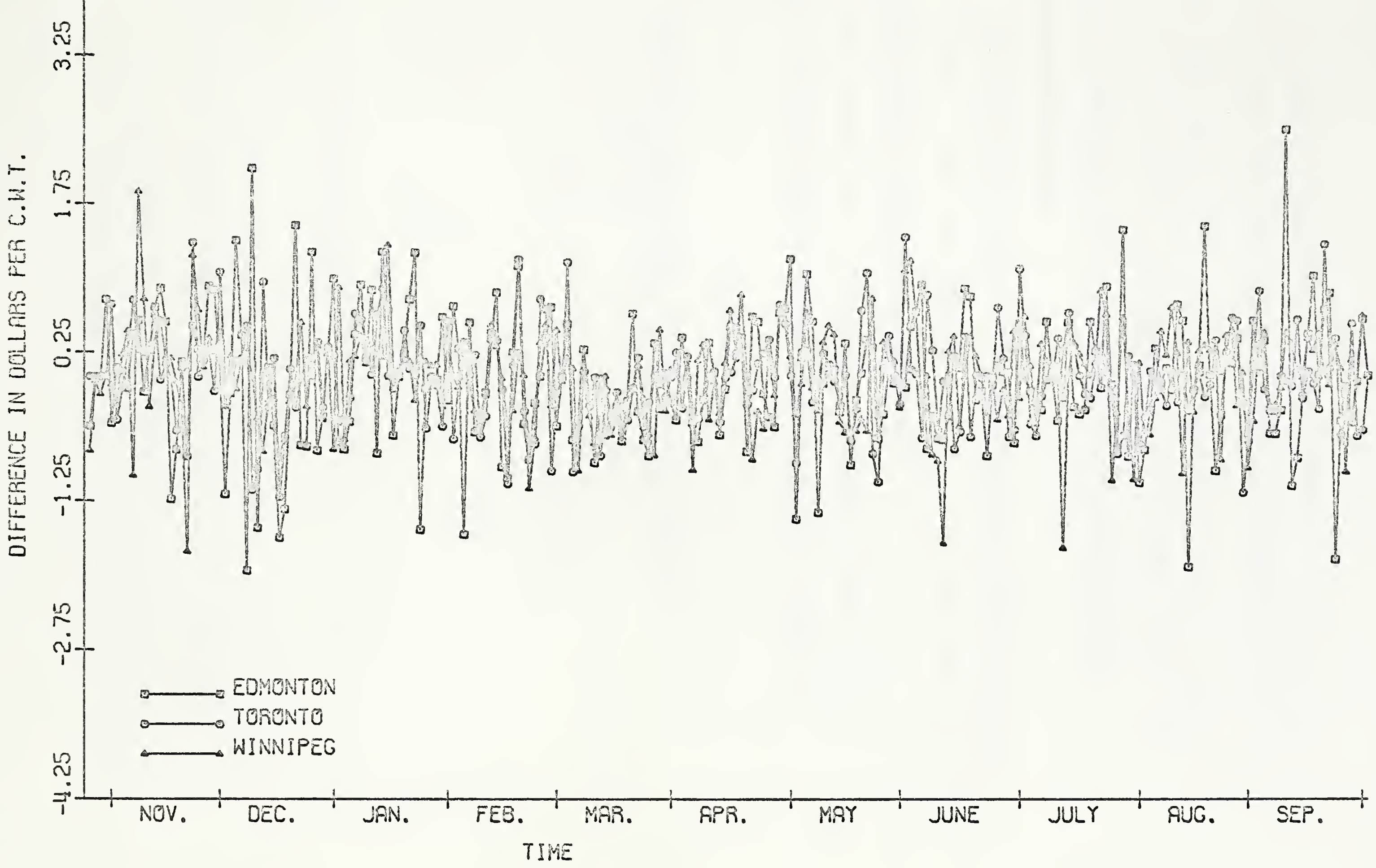


Figure 4-14

FIRST DIFFERENCES AT EDMONTON, TORONTO AND WINNIPEG 1969/70



clear trends appear in the first difference prices. The figure does show, however, that the price differences in each market seem to have fluctuated less than in 1967 and 1968. The extent of this narrowing in fluctuation is examined more precisely later in this chapter when correlation coefficients for first differences are scrutinized.

Correlation Coefficients

The preceding section presented graphically pricing patterns as they existed in 1969 and 1970. This section duplicates the analysis statistically using correlation coefficients.

The correlation coefficients of absolute prices and price changes on the three markets in 1969-1970 are given in Table 4-7.

Table 4-7

CORRELATION COEFFICIENTS OF DAILY PRICE LEVELS AND PRICE CHANGES FOR THREE TERMINAL MARKETS WITH EACH MARKET IN TIME t, 1969-1970

	Edmonton	Winnipeg	Toronto
Edmonton		0.23	0.20
Winnipeg	(0.98)*		0.31
Toronto	(0.97)*	(0.98)*	

* Values bracketed give correlation coefficients of absolute daily prices.

The correlation coefficients for price differences in Table 4-7 range from a low of 0.20 (Edmonton-Toronto) to a high of 0.31 (Winnipeg-Toronto). All coefficients in Table 4-7 are statistically the same as their respective coefficients in Table 4-1. This suggests that under

the new marketing structure in Alberta in 1969-1970, intermarket price responsiveness has not decreased when compared to the old market structure in Alberta in 1967-1968.

Likewise, the coefficients for absolute daily prices range from a low of 0.97 to a high of 0.98. Thus daily price levels among markets remain highly correlated. All coefficients presented in Table 4-7 are significant at the 99 percent level of confidence.

There has been no significant increase in the coefficients of first differences in Table 4-7 as compared to Table 4-1. The actual correlation of price differences is still very low. Because these unlagged correlations give no indication of possible information flows, Table 4-8 was constructed to illustrate correlation coefficients between daily price changes with one or more of the markets lagged one, two, or three days.

The coefficients in Table 4-8 do not indicate any substantial increases in correlation between market price differences when a one or more day lag is introduced. Neither does comparing Table 4-8 with Table 4-2 bear out any significant changes due to the change in market structure in 1969. One can, therefore, state that even under the marketing board structure, market information flows are difficult first to identify and second to determine in their direction of flow. The increase in correlation of unlagged first differences indicates that the markets have become somewhat more responsive to price changes, but it still appears that the absolute price levels of the three markets are used as guides in the individual pricing patterns of the three markets under study.

Table 4-8

CORRELATION COEFFICIENTS OF DAILY PRICE CHANGES FOR THREE TERMINAL MARKETS WITH ONE MARKET LAGGED ONE, TWO, AND THREE DAYS, 1969-1970

	Edmonton t	Winnipeg t	Toronto t	Edmonton t-1	Winnipeg t-1	Toronto t-1	Edmonton t-2	Winnipeg t-2	Toronto t-2	Edmonton t-3	Winnipeg t-3	Toronto t-3
Edmonton t	1.00	0.23	0.20	-0.08	0.29	0.13	-0.23	-0.04	-0.00	-0.07	-0.02	-0.10
Winnipeg t	0.23	1.00	0.31	0.12	0.07	-0.02	0.00	-0.03	0.03	-0.01	0.03	0.05
Toronto t	0.20	0.31	1.00	0.21	0.24	0.01	-0.14	0.04	-0.23	-0.11	-0.08	-0.07
Edmonton t-1	-0.08	0.12	0.21	1.00	0.23	0.20	-0.08	0.29	0.13	-0.23	-0.04	-0.00
Winnipeg t-1	0.29	0.07	0.24	0.23	1.00	0.31	0.12	0.07	-0.02	0.00	-0.03	0.03
Toronto t-1	0.13	-0.02	0.01	0.20	0.31	1.00	0.21	0.24	0.01	-0.14	0.04	-0.23
Edmonton t-2	-0.23	0.00	-0.14	-0.08	0.12	0.21	1.00	0.23	0.20	-0.08	0.29	0.13
Winnipeg t-2	-0.04	-0.03	0.04	0.29	0.07	0.24	0.23	1.00	0.31	0.12	0.07	-0.02
Toronto t-2	-0.00	0.03	-0.23	0.13	-0.02	0.01	0.20	0.31	1.00	0.21	0.24	0.01
Edmonton t-3	-0.07	-0.01	-0.11	-0.23	0.00	-0.14	-0.08	0.12	0.21	1.00	0.23	0.20
Winnipeg t-3	-0.02	0.03	-0.08	-0.04	-0.03	0.04	0.29	0.07	0.24	0.23	1.00	0.31
Toronto t-3	-0.10	0.05	-0.07	0.00	0.03	-0.23	0.13	-0.02	0.01	0.20	0.31	1.00

Intermarket Price Spreads

It is hypothesized that intermarket price spreads among the three markets have decreased following the establishment of the Alberta Hog Producers Marketing Board. Tables 4-9 and 4-10 illustrate the price difference of each market from the three-market average and the intermarket price spreads of the three markets respectively.

Table 4-9

AVERAGE DAILY PRICE DIFFERENCE OF DRESSED WEIGHT HOGS IN DOLLARS PER HUNDREDWEIGHT FROM THREE-MARKET AVERAGE, 1969-1970

Market	Price Difference
Toronto	+2.01
Three-Market Average	Base
Winnipeg	-0.47
Edmonton	-1.54

Table 4-9 shows that Toronto's average price is still the greatest and $2.01 per hundredweight greater than the three-market average. Winnipeg's average price is 47 cents below the average (down from $.06 in Table 4-3), and Edmonton's average price is $1.54 per hundredweight below the three-market average (compared to $1.91 per hundredweight below the average in 1967-1968). Thus Edmonton's average price has strengthened relative to the three-market average in 1967-1968; Toronto's average has remained basically the same; Winnipeg's average has dropped relative to the three-market average.

Table 4-10

AVERAGE DAILY PRICE DIFFERENCE OF DRESSED WEIGHT HOGS IN DOLLARS PER HUNDREDWEIGHT BETWEEN EACH OF THE THREE TERMINAL MARKETS, 1969-1970

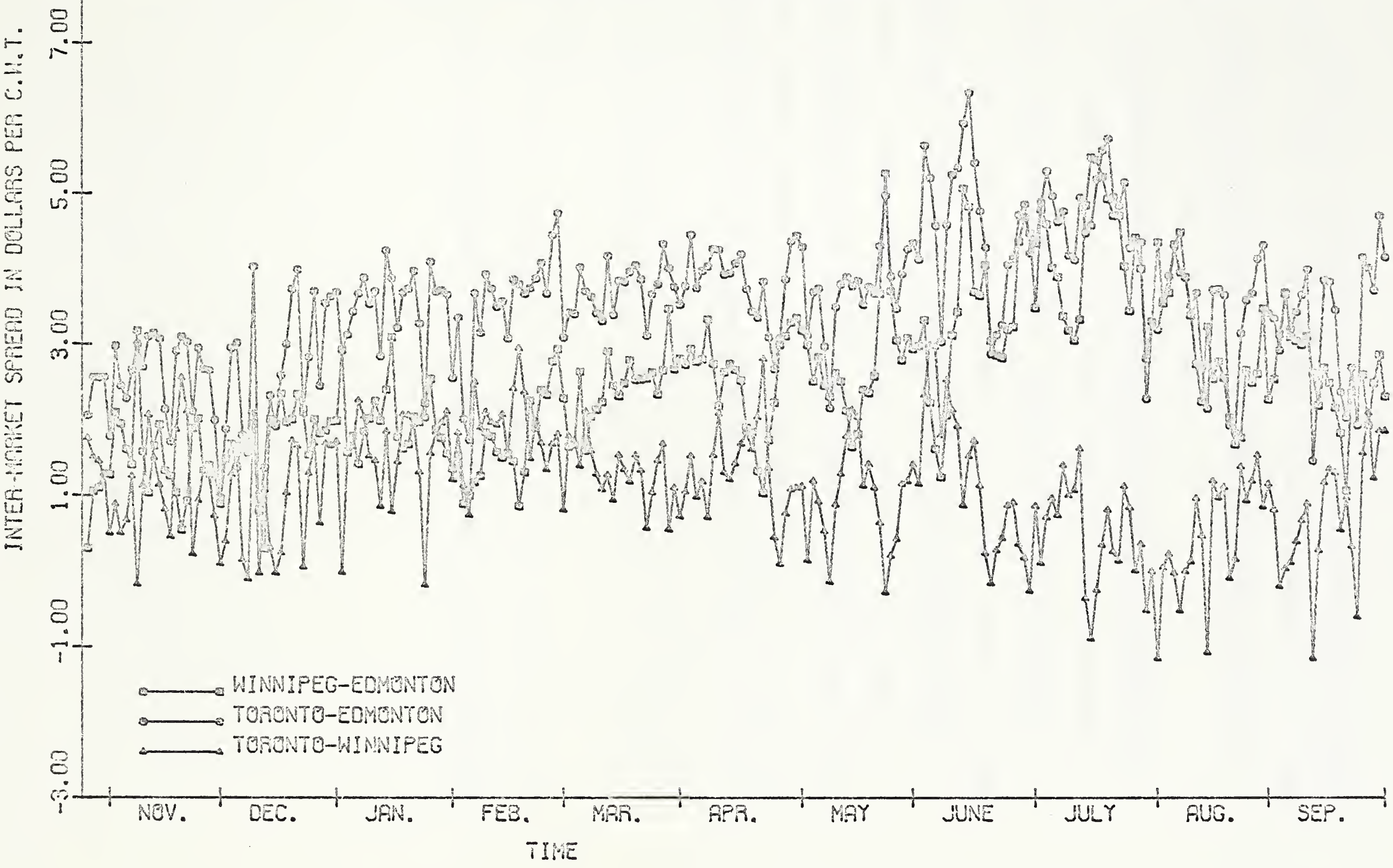
j i	Winnipeg	Edmonton
Toronto	2.48	3.55
Winnipeg		1.07

Table 4-10 illustrates the same features as Table 4-9, but in more detail. It is to be read as "the price of dressed weight hogs in market i is on the average Pij dollars higher than the price in market j." It is thus shown that the intermarket price spread between Toronto and Edmonton dropped from $3.89 per hundredweight to $3.55 per hundredweight in 1969-1970. Likewise, the price spread between Winnipeg and Edmonton dropped from $1.85 per hundredweight in 1967-1968 to $1.07 per hundredweight in 1969-1970. It is interesting to note that the Toronto-Winnipeg price spread increased from $2.04 per hundredweight in 1967-1968 to $2.48 per hundredweight in 1969-1970.

A graphical illustration of these intermarket price spreads in 1969-1970 appears in Figure 4-15. It shows once again that the price spreads among markets on a day-to-day basis are very erratic. It does indicate, however, that when prices were high in the latter months of 1969 and early months of 1970, price spreads were narrower than when prices began to fall in the spring of 1970. Once again, the probable explanation for this occurrence would be the relative position of each province with respect to exports when hogs are in low supply as compared to when hogs are in abundant supply.

Figure 4-15

HOG PRICE SPREADS, TORONTO-WINNIPEG, TORONTO-EDMONTON, WINNIPEG-EDMONTON 1969/70



A statistical analysis on intermarket price spreads as opposed to intermarket freight rate differentials was not performed on the 1969-1970 data because of the shortness of the 1969-1970 time series data and the lack of 1970 freight rate data.

The general observations made in this section of Chapter IV illustrate the effects of the Alberta Hog Producers Marketing Board on hog prices over time and over space. There has been no increase in correlation between absolute price levels and a slight increase in lagged and unlagged first differences of prices. The market price spreads between Edmonton and Winnipeg and Edmonton and Toronto have narrowed; consequently, Edmonton's mean market price has strengthened with respect to the three-market average price. Whether or not these occurrences can be attributed solely to the change in the Alberta hog market structure is debatable, but from the evidence at hand, it would seem that the change in market structure has had a definite positive result for the Alberta hog producers.

The next two chapters will utilize the price results obtained in this chapter in developing a short-run supply model for the Edmonton market area.

CHAPTER V

THEORETICAL FRAMEWORK FOR THE SUPPLY MODEL

The economic model developed in this chapter is used to explain and forecast supply patterns existing in the Edmonton terminal market. Its main purpose is to simplify the underlying relationships that influence the live hog sector of the economy and to provide a framework for the subsequent empirical analysis by suggesting explanatory variables, restrictions, and functional forms. The model as presented is based on the assumption that the live hog market in the Edmonton area is representative of other Alberta and Canadian hog markets. This assumption presupposes that any interregional or interprovincial relationships in the hog market are inherent in the data and consistent for analytic purposes. As a result the Edmonton market area may be considered in isolation for the purpose of forecasting short-run supply response for hogs.

Two basic methods can be employed in developing economic models designed to explain and forecast supply. One method involves the specification of structural relationships affecting the day-to-day quantity supplied on the market, and the other calls for development of price expectation functions at both the producer and the packer level. In this analysis both methods are employed; that is, supply structures will be discussed, their functions will be specified, and certain price expectation formulations will then be integrated with them.

Basic Assumptions

The economic supply model developed in this thesis is based on two major assumptions. The first assumption deals with the behavior of market participants in the industry. It is assumed that both producers and buyers (packers) operate in a perfectly competitive market structure and that the price of live hogs is, therefore, determined by the intersection of the producers' supply of and the packers' demand for live hogs. This implies that neither producers nor buyers can individually influence price determination.[1] A second assumption is that producers and buyers are operating under conditions aimed at maximizing firm profits.

The development of the economic relationships and variables constituting the short-run hog economy is highly relevant to the ensuing analysis. Figure 5-1 gives a general view of the major relationships in the hog economy. This flow chart, developed by Leuthold, represents both supply and demand relationships. For our purposes, we are interested mainly in the factors and variables affecting supply; however, the entire chart is included in order to provide the reader with an illustrative outline of the entire hog economy.

In Figure 5-1, items representing physical quantities appear in boxes; factors representing values (prices, incomes) appear in circles. The multitude of indirect forces that constitute the live hog marketing system and that potentially can affect market operations and prices are included within the dash-bordered box. Factors of this type

---

[1] The assumption as stated is included to simplify the statistical development of the supply model. It is realized that in reality the market structure of the Alberta hog industry consists of an oligopsony at the packer (buyer) level and a competitive (many sellers) structure at the producer level.

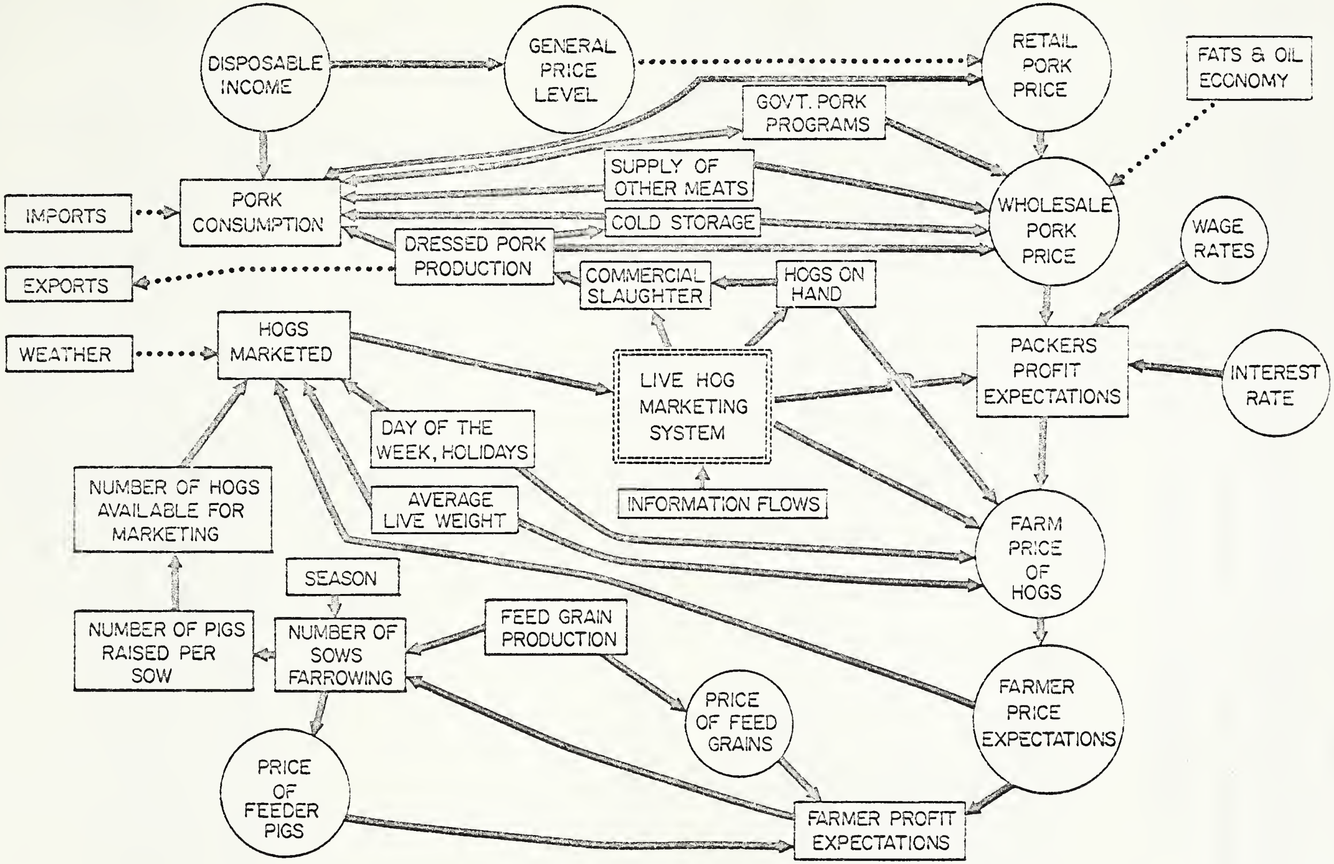


Figure 5-1

MAJOR RELATIONSHIPS IN THE HOG ECONOMY

Source: Leuthold, *op. cit.*

include grade of hogs, size of lots, hog conformation, breed, types of buyers, geographic areas, etc. Important influential factors are connected by solid lines, while the broken lines designate factors of minor or random influence. Arrows are used to depict the principal direction of influence for related factors, and lines with double pointed arrows indicate possible simultaneous relationships.

The Supply Function

The quantity of live hogs demanded is the demand for an input in a production process, but the quantity of live hogs supplied is the output of another production process.[1] The latter of these two processes reflects the various farm inputs necessary to produce a fed hog. Consequently, examination of the producers' production function becomes a natural starting place in the formulation of the supply function for live hogs.

A typical hog producer's production function can be stated as follows:

$$X_h = \phi\ (A_1, A_2, \ldots, A_i \mid A_{i+1}, \ldots, A_n),$$

where

X_h is output of live hogs,

$A_1, \ldots A_i$ are variable inputs, and

$A_{i+1}, \ldots, A_n$ are fixed inputs.

The major inputs considered by a farmer in his production function are feed, feeder pigs, labor, and capital, as illustrated in Figure 5-1. The feed input is comprised of coarse grains, small grains, and

---

[1] Leuthold, op. cit., p. 67.

supplements needed to produce a market hog. The producer has the alternative of either producing his own feed inputs or purchasing them from other sources. Feeder pigs represent the number of pigs the farmer farrows and saves or the number purchased for the purpose of feeding. This latter input is a function of the number of sows farrowing, the average size of litters, and the survival rate. The labor input is represented by the farmer's labor, as well as by possible hired labor. The capital requirement includes all fixed assets, such as buildings and equipment needed for hog production, and such variable expenses as medication, veterinary fees, transportation, etc.

Assuming that producers are profit motivated, the supply of any product can generally be represented as a function of its own price and the price of the inputs.[1] Applying this principle to the production function as developed above, the supply of live hogs is dependent upon the price of live hogs and the prices of labor, capital, feed, and feeder pigs. Because we are specifically interested in daily supplies and because daily supplies are necessarily limited to short-run variable inputs, capital includes only expenditures for variable inputs.

The variables as defined in the supply function must be considered in the proper time horizon, for it is not always the current or actual price that influences production and supply, but often an expected or past price. The Edmonton terminal market generally concluded its trading of live hogs early in the afternoon; it was, therefore, unlikely that a farmer could respond to an established price within the day. In other words, once the market opened for the day and a dressed

---

[1] Leuthold, op. cit., p. 68.

hog price was established, active trading generally terminated before a farmer could ship his hogs to the market. Cases in which producers were relatively close to the market and could readily deliver their hogs subsequent to early afternoon market reports proved exceptions to this rule. On the whole, it was assumed that farmers responded to an expected price in time period t in their marketing decisions.

It is futile to attempt to formulate a large number of price expectation models which might possibly be utilized by farmers in anticipating the daily price of hogs. A study performed by Darcovich and Heady formulated and tested several different models on yearly hog prices.[1] Only three of these models apply to our short-run analysis and provide accurate predictions. They are (1) expecting that the current price will be the same as the previous period's price, (2) constructing a weighted moving average of past prices, and (3) constructing a simple moving average of past prices.

Because of time restrictions imposed in conducting this study, only the first of the three mentioned expectation models was developed and tested. Leuthold tested eleven expectation models in his study and found that price lagged one day produced the highest R^2 and was significantly different from zero at the 99 percent level of confidence.[2] Various combinations of weighted and simple moving averages did not significantly increase the R^2 over the simple one day price lag; therefore,

---

[1] William Darcovich and Earl O. Heady, Application of Expectation Models to Livestock and Crop Prices and Products, Research Bulletin 438 (Ames, Iowa: Iowa Agricultural Experiment Station, February, 1956).

[2] Leuthold, *op. cit.*, p. 90.

the price expectation model adopted for this analysis was the first such model outlined above.

Assuming the hog producer to be profit motivated, the cost of inputs must be considered at the time the actual costs were incurred. It was assumed for our purposes that the average feeding time necessary to carry a hog from 40 pounds to market weight was four months. Thus the prices of the inputs were set at their market prices, or opportunity costs, four months prior to the market date. It was further assumed that the prices of feeder hogs were identical whether produced by the farmer or purchased elsewhere.

Figure 5-1 further illustrates that there were factors affecting the daily supply of hogs other than the price of inputs. One such factor pointed out by Schneidou, Pherson, and Cox is the volume of hogs delivered to market at various times of the week.[1] The three discovered that deliveries on Monday and Tuesday were substantially higher than on the remaining days of the week due to the fact that farmers expected greater demands early in the week and had more time over the weekend than during the week to prepare hogs for delivery. This known phenomenon was dealt with by utilizing the dummy variable technique, which shifted the supply function according to the day of the week.[2]

---

[1] R. E. Schneidou, V. W. Pherson, and C. B. Cox, Is There a Best Market Day?, Bulletin 712 (Lafayette, Indiana: Purdue University Agricultural Experiment Station, October, 1958).

[2] An excellent reference outlining the statistical and economic use of the dummy variable technique is found in D. B. Suits, "Use of Dummy Variables in Regression Equations," Journal of the American Statistical Association, LII (1957), p. 548.

The dummy variable technique was also employed in dealing with the seasonal trend related to hog farrowing. This trend can have a distinct effect on daily deliveries and must be included in the supply function. Another variable to be taken into account was weather conditions. Daily supplies were affected by weather; i.e., supply might be lower than normal during a bad storm in winter months but might be higher than normal on a rainy day during seeding or harvest. These varying conditions of temperature and precipitation were handled by dummy variables.

The effect of holidays on daily deliveries was important. It was hypothesized that a holiday falling on a Monday would have a marked effect on deliveries for the remaining days of the week, whereas a Friday holiday would likely have little effect considering the fact that small volumes were usually traded on Friday. This holiday factor was similarly included in the supply function through the use of dummy variables.

The marketing pattern as outlined above, along with seasonal trends, can cause large variations in the number of hogs available for marketing on any one day. The actual number of hogs available for marketing is a function of a number of different factors, including the number of sows bred, pigs per litter, death loss, and farm slaughtering rates. Because it would be unreasonable to include each of these variables separately in the supply function, a variable that approximates the number of hogs available for marketing is used.

Gathering all the independent variables sighted above, the supply function for live hogs can be stated as follows:

$$Q^s_t = \phi \; P^*_{h(t)}, P_{l(t-120)}, P_{c(t-120)}, P_{f(t-120)}, P_{p(t-120)}, D_d, D_s, Q^*_a, D_w, D_h,$$

where

Q^s = number of live hogs supplied

P^*_h = expected price of live hogs

P_l = wage rate of farm labor

P_c = price of capital (interest rate)

P_f = price of feed

P_p = price of feeder pigs

D_d = dummy variables representing days of the week

D_s = dummy variables representing seasons of the year

D_w = dummy variables representing weather changes

D_h = dummy variables representing holiday effect

Q^*_a = number of hogs available for marketing

t = time in days.

Functional Form

The next step in the development of the supply model involves the specification of the functional form of the multiple regression equation. It was hypothesized at the outset that producers and buyers respond to absolute price and quantity changes in the marketplace. Assuming that this hypothesis is true, a simple linear functional form is adequate for developing the supply function. It is possible, however, that producers respond differently depending upon the level of price or quantity. If this is the case, a functional form that measures this difference in response, depending on whether price and/or supply is high

or low, must be used. Stated another way, a functional form that measures response in accordance to percentage change in price and quantity rather than to absolute price and quantity changes must be developed.

The logarithmic functional form is designed to take this latter type of market participant response into account. Equations of this type reflect constant percentage changes, whereas simple linear equations reflect constant absolute changes. Both functional forms are utilized in the development of the short-run supply function. The relative merits of each and the choice of the functional form that provides the best statistical fit will determine which form is chosen for the supply model.

A logarithmic supply equation suggests that to induce identical supply responses, the change in price must be greater at high price levels than at low price levels. Conversely, for a small change in price, the change in quantity is greater at lower than at higher levels of price. A linear supply equation suggests that, regardless of the level of supply or price, the response by the producer will be the same.

Statistical Assumptions

The construction of a multiple regression supply forecasting model would be incomplete without the specification of certain statistical assumptions on which the model is developed. The theoretical relationships defined for the supply function cannot be expected to hold exactly true in every time period. In a model of this complexity, certain unobservable phenomenon likely exist, and appropriate assumptions with respect to the effect these phenomena have on our theoretical

relationships must be made. Using standard statistical notation, the supply function can be written as follows:

$$Y_{(t)} = \beta_0 + \beta_1 X_{1(t)} + \beta_2 X_{2(t)} + \ldots \beta_m X_{m(t)} + \varepsilon_{(t)}$$

$t = 1, \ldots t$, when the linear functional form is used, or

$$\log Y_{(t)} = \log \beta_0 + \beta_1 \log X_{1(t)} + \beta_2 \log X_{2(t)} + \ldots \beta_m \log X_{m(t)} + \varepsilon_{(t)}$$

$t = 1, \ldots t$, when the logarithmic functional form is used, where Y represents the dependent variable, $X_{1(t)}$ through $X_{m(t)}$ represent the independent variables, and β_0 through β_m are parameters. The unobserved variables are represented by the stochastic disturbance (an error) term $\varepsilon_{(t)}$, which is assumed to be a variable with a probability distribution centered at zero and a finite variance σ^2.

In order to insure that classical least squares regression yields unbiased and consistent estimates of the parameters of each independent variable in the supply function, it becomes necessary to make further statistical assumptions concerning the error term and the functional form of the model. Thus it is further assumed that:

1. The independent variables are a sample from a stationary multivariate process and are uncorrelated.
2. The process generating the independent variables is uncorrelated with the process generating the error terms.
3. There are no exact linear relationships among the independent variables.

If the above assumptions are applied, it can be shown that the classical least squares estimators of β_0 through β_m and σ^2 are asymptotically unbiased and consistent.[1] The assumption that the error term is

---

[1] A. S. Goldberger, Econometric Theory (New York: John Wiley and Sons, Inc., 1964), pp. 354-355.

normally distributed allows for the use of conventional hypothesis testing procedures without affecting the properties of the independent variables. The following chapter gives the empirical results of the supply model when economic data are applied to the supply function.

CHAPTER VI

APPLICATION OF THE SUPPLY MODEL TO THE EDMONTON MARKET AREA

The models presented in the previous chapter relate the supply of live hogs to various explanatory factors such as the price of dressed weight hogs, the wage rate of farm labor, the price of feed, etc. This chapter is an attempt to quantify that theoretical model, to test the explanatory power of the independent variables, to choose the best functional form for the supply model, and to apply the estimated model to the problem of predicting daily live hog supply. The data used to estimate this model are described in the following section.

Discussion of Data Utilization

1. Price of Live Hogs. The average daily price of live hogs for the Edmonton market was represented by the price of dressed weight Grade A Hogs as reported by the Canada Department of Agriculture Market Information Services, 1967-1968.

2. Quantity of Live Hogs Supplied. The quantity of live hogs supplied represented the total number of barrows and gilts delivered daily for sale at the Edmonton market, 1967-1968.

3. Price of Farm Labor. The daily price of farm labor was calculated by taking the quarterly average farm labor rate and reducing it to a daily wage rate. This data was acquired from the 1967 and 1968 Canada Year Books based on Dominion Bureau of Statistics reports.

4. Price of Feed. The price of Number 1 feed barley was used to represent the price of feed. This particular grade of barley

is the one used in calculating the Canadian hog-barley price ratio. The prices were available as monthly averages and reported in the Annual Report of the Canadian Wheat Board, 1967 and 1968.

5. Number of Hogs Available. The number of hogs available for market was assumed to be the same as the number of pigs born six months prior to marketing day. The number of pigs born daily was estimated by a linear interpolation between the average number of daily births for each month. To obtain a representative figure for the Edmonton market, 65 percent of the births in Alberta were taken as an indication of birth in the Edmonton market area.

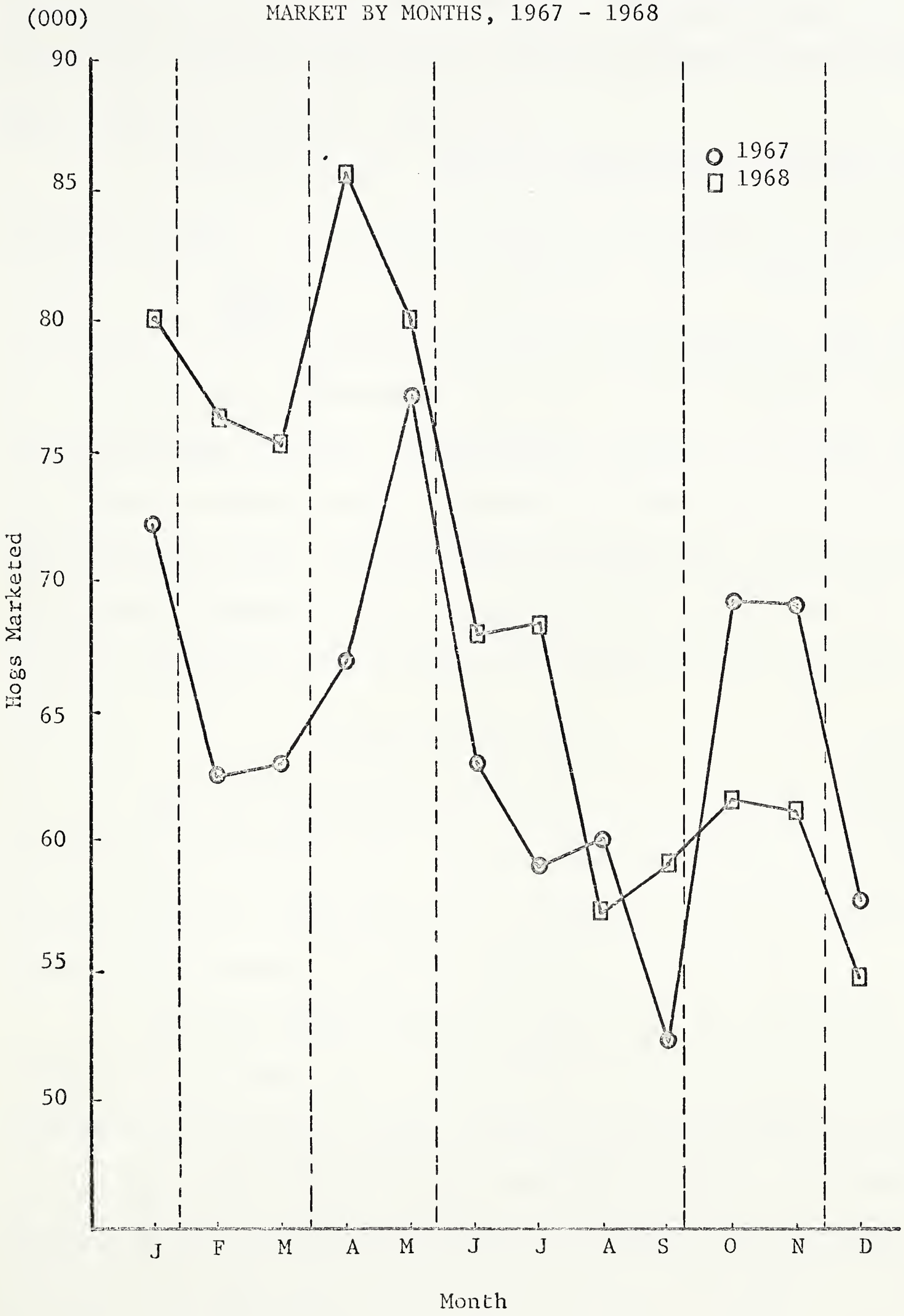
6. Days of the Week. Dummy variables were used for Monday, Tuesday, Thursday, and Friday in the supply function. Dummy variables could not be specified for all five days of the week because this created a linear combination in the columns of the raw moment matrix and made the matrix singular. Therefore, Wednesday was chosen as the base.

7. Seasons of the Year. A seasonal dummy variable was created by dividing the year into two seasonal groups, one representing the months in which quantity was generally increasing over the previous month and the other representing the months in which quantity was generally on the decline. The months in the first group were January, April, May, October, and November. These months were represented by a 1.0 value for the variable. The other seven months were represented with a 0.0 value for the variable.

Figure 6-1 shows these seasonal variations by illustrating graphically the quantity of hogs supplied monthly to the Edmonton market. The vertical lines divide the year into six time periods, each comprising a portion of one of the groups described above.

Figure 6-1

TOTAL SUPPLY OF LIVE HOGS TO EDMONTON TERMINAL MARKET BY MONTHS, 1967 - 1968



8. Holidays. The effect of holidays on supply was also represented by a value for the dummy variable. Holidays falling on a Monday were assigned a value of 0.0; holidays falling on the remaining days of the week received a value of 1.0.

9. Weather Changes. Numerous combinations of weather conditions with respect to their effect on price were possible. The dummy variable technique was also used to represent weather conditions. A 10 degree or greater change in the daily high temperature from that of the previous day resulted in a value of 1.0 being assigned to the temperature dummy variable. Precipitation in excess of one-half inch was similarly accounted for by assigning the dummy variable for precipitation a value of 1.0. In cases where the temperature change was not greater than 10 degrees or the precipitation was less than one-half inch, the respective dummy variables were assigned a value of 0.0.

Model Alterations

Some of the hypothesized variables in the supply function were not tested empirically because of data limitations, problems of quantification, or lack of variation. As a result, the actually estimated model deviates somewhat from the proposed theoretical model.

Variables showing little variation over the time period studied were excluded from the theoretical model because an independent variable must show some variation during the relevant period in order to help explain the variance of the dependent variable. Two variables excluded for this reason were the price of capital; i.e., interest rate and farm wage rate.

The price of feeder pigs was also excluded from the econometric model. No feeder pig prices were available in Canada; consequently, they were excluded from the model by necessity rather than by economic reasoning.

In addition, further model alterations resulted from the preliminary analysis. Several variables were eliminated because they did not have a significant effect upon the dependent variable; that is, the coefficients of the variables were not significantly different from zero even at 5 to 10 percent levels of confidence, and the variables did not increase R^2 a significant amount when added to the equation. Among those variables excluded for this reason were the dummy variables representing seasons of the year and temperature changes and the variable representing the number of hogs available for market.

In each of the cases cited above, the variable failed to explain much of the variation of the dependent variable. The variable representing the number of hogs available for market was crudely measured, and its exclusion from the supply equation could be attributed to this factor. Temperature changes were likely insignificant because of the erratic weather conditions facing producers and their inability to react consistently to these changes. The dummy variable representing seasonal trends was similarly insignificant, perhaps because of the method employed in measuring the variable.

It was assumed that any specification problems introduced by the exclusion of the above-mentioned variables would not seriously affect the results. It is possible that some of the excluded variables

would have a cancelling effect on each other. In any event, the effect of excluding the variables in question was not expected to be great.

During the preliminary analysis the supply function was estimated using both of the hypothesized functional forms: logarithmic and linear. Because almost no distinction between the two forms regarding the potential ability of the independent variables to explain the variation of the dependent variable appeared and because the ratios of coefficients over standard errors were nearly identical in magnitude for each corresponding independent variable, only the hypothesized linear equations were used for the estimations.

Selection of a Model

Having discussed those variables which were eliminated from the proposed hypothetical model, the basic supply function can now be expressed in equation form. The general supply equation was:

$$\Delta Q_t = \beta_1 P_t^* + \beta_2 M + \beta_3 T + \beta_4 Th + \beta_5 F + \beta_6 H + \beta_7 P + \beta_8 \Delta P_{f(t-120)} + u(t) \quad (1)$$

where

Q = number of live hogs supplied

P_t^* = farmer's price expectation

H = 0.0 if Monday, 1.0 for other days of the week in which a Monday holiday occurred

P = 1.0 if precipitation was $\geq$ .5 inches
0.0 if otherwise

M = 1.0 if Monday
0 if otherwise

T = 1.0 if Tuesday
0 if otherwise

Th = 1.0 if Thursday
0 if otherwise

$F = \begin{array}{l} 1.0 \text{ if Friday} \\ 0 \text{ if otherwise} \end{array}$

P_f = price of feed barley

t represents time periods in days

$\beta_1, \ldots \beta_8$ were parameters

Δ signifies taking the first difference in value between two adjacent periods, and

u(t) was an error term.

Estimation Results

Using two years of data, several combinations of time periods to test the model were possible. In order to observe how much the coefficients of equation (1) might change over time, the equation was estimated over 15 alternative time periods.

The procedure utilized a 12-month time series in each estimation. The equation was first estimated using data covering the entire year of 1967. It was then estimated using data from February, 1967, through January, 1968, next, from March, 1967, through February, 1968, and so on. This pattern of dropping one month in 1967 and adding the next month in 1968, but always maintaining a time series of 12 months, was followed until reaching the last possible combination using data for the entire year of 1968. Equation (1) was also estimated using the full two years of data. A 15th combination for estimation used a six-month time series from February, 1970, through July, 1970. The inclusion of this special six-month time series served to test the forecasting ability of the equation using supply and price data generated under the

new Alberta Hog Producers Marketing Board system of marketing hogs in Alberta.

Supply Coefficients

The supply function was estimated for the 15 time periods outlined above. The coefficients appear in Table 6-1. Looking at the first row of the table, the coefficients for the days of the week, the price of barley, and precipitation were all significantly different from zero at the 99 percent level of confidence. The coefficient of lagged price did not enter the regression equation because it was not significantly different from zero even at low levels of confidence. The coefficient for the price of feed barley did not have the expected sign. Because the sign was positive, if the price of barley increased in time period t-120, then the supply of hogs would increase in time period t. This generally would not be the case, for an increase in feed barley price should result in a decrease in the number of hogs delivered three months hence. A possible explanation for this occurrence could be that it reflects the chronic "inners" and "outers" in hog production. As the price of barley increased, the sale of feed grains became more attractive, resulting in a heavier slaughter of sows and gilts in the months immediately following a substantial increase in feed grain prices. Consequently, in those supply equations using the variable representing the change of barley prices, the resulting error in supply estimations was greater than in those equations wherein that variable did not appear. The final coefficient entering the equation was the dummy variable representing Tuesday when Monday was a holiday.

Table 6-1

RESULTS OF SUPPLY EQUATION ESTIMATIONS FOR
THE EDMONTON MARKET, 1967-1968
DEPENDENT VARIABLE: ΔQ_t

	Independent Variables[a]						
Time Period	Constant	P_{t-1}	Monday	Tuesday	Thursday	Friday	Price of Barley
Jan. 1967- Dec. 1967	-3,517	--	3,571* (216.6)	3,646* (210.3)	4,585* (209.6)	1,163* (211.1)	2.3* (1.0)
Feb. 1967- Jan. 1968	-3,544	--	8,612* (199.9)	3,574* (196.1)	4,609* (195.4)	1,176* (197.2)	2.4* (0.9)
Mar. 1967- Feb. 1968	-3,617	--	8,788* (212.9)	3,565* (206.3)	4,678* (205.4)	1,221* (208.6)	2.7* (1.0)
Apr. 1967- Mar. 1968	-3,719	--	9,078* (222.7)	3,521* (219.4)	4,851* (218.4)	1,327* (220.5)	2.8* (1.1)
May 1967- Apr. 1968	-3,708	2.7° (2.6)	9,446* (251.4)	3,357* (244.2)	4,808* (244.9)	1,445* (250.1)	2.6* (1.2)
June 1967- May 1968	-3,826	4.4° (3.1)	9,703* (280.7)	3,442* (275.0)	4,936* (273.3)	1,540* (278.7)	2.8* (1.4)
July 1967- June 1968	-3,882	5.4° (3.3)	9,914* (286.1)	3,299* (281.8)	4,978* (282.1)	1,583* (285.7)	2.9* (1.4)
Aug. 1967- July 1968	-3,864	4.0° (3.4)	10,089* (295.4)	2,940* (289.7)	4,880* (292.6)	1,559* (295.0)	--
Sept. 1967- Aug. 1968	-3,948	--	10,292* (286.7)	2,702* (282.3)	4,929* (284.8)	1,599* (286.3)	--
Oct. 1967- Sept. 1968	-3,956	--	10,332* (284.6)	2,641* (278.2)	4,932* (280.2)	1,613* (283.7)	--
Nov. 1967- Oct. 1968	-3,906	--	10,144* (324.6)	2,776* (321.0)	4,757* (321.5)	1,620* (325.6)	--
Dec. 1967- Nov. 1968	-3,992	--	10,176* (337.5)	2,922* (335.4)	4,777* (329.7)	1,759* (337.7)	--
Jan. 1968- Dec. 1968	-3,984	1.9° (1.6)	10,072* (312.8)	2,729* (310.0)	4,738* (314.4)	1,819* (316.2)	--
Jan. 1967- Dec. 1968	-3,726	1.9* (1.3)	9,312* (198.8)	3,173* (263.9)	4,652* (192.7)	1,477* (196.9)	1.6* (1.1)
Feb. 1970- July 1970	-4,011	--	8,759* (322.5)	4,376* (315.8)	5,255* (316.0)	1,517* (318.9)	--

continued...

Table 6-1 (continued)

Time Period	Precipitation	Tuesday (holiday week)	Wednesday (holiday week)	Friday (holiday week)	R^2	F-Value
Jan. 1967- Dec. 1967	-583 (358.6)	7,852* (538.9)	--	--	0.907	168.1
Feb. 1967- Jan. 1968	-581* (331.4)	7,913* (499.4)	--	-576° (449.4)	0.920	198.7
Mar. 1967- Feb. 1968	-630* (351.5)	7,924* (529.4)	--	-557° (476.6)	0.914	198.1
Apr. 1967 Mar. 1968	-667* (374.0)	8,092* (569.3)	--	-548° (511.9)	0.906	179.2
May 1967- Apr. 1968	-771* (414.6)	8,409* (623.6)	--	-590° (562.9)	0.894	144.0
June 1967- May 1968	--	8,144* (811.0)	807° (708.9)	--	0.970	114.7
July 1967- June 1968	--	8,322* (830.4)	856° (725.4)	--	0.871	115.0
Aug. 1967- July 1968	--	9,099* (756.1)	--	--	0.873	117.4
Sept. 1967- Aug. 1968	806* (618.9)	9,015* (653.7)	--	--	0.889	135.4
Oct. 1967- Sept. 1968	803° (608.7)	9,528* (653.9)	-801+ (578.5)	-625° (578.1)	0.894	167.2
Nov. 1967- Oct. 1968	--	9,412* (841.0)	--	-739° (735.4)	0.853	116.0
Dec. 1967- Nov. 1968	--	9,276* (868.2)	--	-823° (761.4)	0.843	116.9
Jan. 1968- Dec. 1968	--	9,327* (930.2)	-2,576* (788.0)	-914° (790.7)	0.861	113.1
Jan. 1967- Dec. 1968	--	8,606* (535.0)	-1,133* (498.6)	-691+ (497.7)	0.863	239.4
Feb. 1970- July 1970	--	--	--	--	0.882	179.5

[a] Coefficients are on top; standard errors are in brackets.

[*] Significant at the 99 percent level of confidence.

[+] Significant at the 95 percent level of confidence.

[°] Significant at the 90 percent level of confidence.

When a holiday fell on a Monday, the normal Monday delivery was generally postponed until Tuesday, hence, Tuesday's inclusion in the function.

The daily dummy variables caused the intercept of the supply function to shift according to the day of the week. The Monday coefficient of 8,571 indicates that the absolute change in quantity on Monday was on the average (8,571 x 1 = 8,571) larger than the absolute change in quantity on Wednesday. Also, the absolute changes in quantity on Tuesday, Thursday, and Friday were respectively 3,646, 4,585, and 1,163 greater than the absolute change in quantity on Wednesday. This phenomenon seems quite normal because Monday, Tuesday, and Thursday were traditionally the high sales days in the Edmonton market.

Table 6-1 illustrates that the variables representing the change in price of feed barley, the change in precipitation, and the dummy variables representing Wednesday and Friday during a week with Monday as a holiday did not enter the regression equation for every time series. In the five cases where the dummy variable representing Wednesday in a holiday week entered the equation, the coefficients ranged from a positive 807 at 90 percent confidence levels to a -2,756 at 99 percent confidence levels. The reason for this occurrence was unknown.

The constant term in all equations remained negative; similarly the sign for the normal daily dummy variables remained positive for all time periods. The range in the magnitudes of the coefficients is illustrated in Table 6-2.

Table 6-2

SUPPLY EQUATION VARIABLES WITH CORRESPONDING COEFFICIENT RANGES, BASED ON 1967-1968 DATA

Variable	Range
ΔP_{t-1}	1.9 - 5.4
Monday	8,571 - 10,332
Tuesday	2,461 - 3,646
Thursday	4,585 - 4,978
Friday	1,163 - 1,819
$\Delta P_{f(t-120)}$	1.6 - 2.9
Precipitation	-581 - 806
Tuesday*	7,852 - 9,528
Wednesday*	-2,756 - 856
Friday*	-914 - -549

* Represents days of week when Monday is a holiday.

In absolute terms, the coefficients of the dummy variables representing the days of the week had the greatest range, and the feed barley coefficients had the narrowest range. If the size of the range is measured as a percent of the absolute value of the coefficients, only the change in price had a percentage variation very different from the others, and it was larger.

The smallest and largest coefficients for each variable as just noted were significantly different from each other at "all" levels of confidence. A small difference between two coefficients for a variable must occur if the coefficients are not to be significantly different from each other. Looking down the columns in Table 6-1, it

can be seen that the majority of the coefficients for each variable were significantly different from each other.

One noticeable trend over the different time periods was that the coefficients for the constant term became increasingly more negative as 1968 data were substituted for 1967 data. Similarly, the coefficients for the days of the week appeared to follow a noticeable pattern. The coefficients for Monday gradually increased until near the end when they leveled off and then dropped. While Monday's coefficients were increasing in magnitude, Tuesday's were generally decreasing with the leveling off and reversal of the pattern occurring at approximately the same time as in Monday's pattern. Thursday, on the other hand, illustrated a pattern similar to Monday's, although with a little less regularity. Friday's coefficients increased consistently over the various time periods; that is, as more 1968 data were substituted for 1967 data, the coefficient for Friday became larger.

Upon observation of Table 6-1, it was noticed that changes in the farmers' price expectations did not consistently enter the supply equations developed. That is, in terms of the regression model, the price coefficients reflected that producers were generally nonresponsive to price changes in 1967 and 1968. In only six of the fourteen cases did price enter the regression equation, and in two of those cases the coefficients were significant only at the 90 percent level of confidence.

From a realistic standpoint, one must expect that hog producers were conscious of price changes in their product and that they would react to price changes on a day-to-day basis. The fact that price coefficients were not important explanatory variables in the regression

compared to Stover's elasticity estimations in 1932, which ranged from 4.0 to 12.0.[1]

The R^2 for the supply function varied from 0.843 to 0.920. In general, as 1968 data were increasingly substituted for 1967 data, the R^2 became smaller in magnitude. This might be explained in part by the fact that prices were generally increasing in 1968 and decreasing in 1967 and that both the lagged price of barley and the precipitation dummy variable were becoming insignificant. The magnitude of the R^2 in the supply equation was relatively large, the dummy variables for days of the week generally accounting for over 95 percent of the explained variation.

Autocorrelation

One of the crucial statistical assumptions made in Chapter V was concerned with the independence of the disturbance terms. To test the validity of this assumption a test for autocorrelation in the residual terms was performed. A suitable test for autocorrelation was available in the Durbin-Watson d statistic.[2]

The procedure was to let $Z_t (t = 1, \ldots, n)$ denote the residuals from a fitted-least-squares regression. We then define

$$d = \sum_{t=2}^{n} \frac{(Z_t - Z_{t-1})^2}{\sum_{t=1}^{n} Z_t^2}$$

---

[1] H. J. Stover, Relation of Daily Prices to the Marketing of Hogs at Chicago, Bulletin 534 (Ithaca, New York: Cornell University Agricultural Experiment Station, January, 1932).

[2] For a complete discussion of autocorrelation, the problems it presents and the Durbin-Watson test see J. Johnston, Econometric Methods (New York: McGraw-Hill, 1960), pp. 177-200.

Exact significance levels for d are not available, but Durbin and Watson have tabulated lower and upper bounds d_L and d_U for various values of n and k where n equals the number of observations and k equals the number of explanatory variables. To conduct a one-sided test of positive autocorrelation, a computed d value was calculated.

If $d < d_L$, the hypothesis of random disturbances is rejected in favor of that of positive autocorrelation. If $d > d_U$, the hypothesis is not rejected. If $d_L < d < d_U$, the test is inconclusive and further observations would ideally be required.

In our instance, the Durbin-Watson d statistic was calculated to be 0.83 which indicates that positive autocorrelation of the residuals does, in fact, exist since the lower boundary for 252 observations is well above the calculated d value. No attempt was made, however, to rectify this situation.

Multicollinearity

Multicollinearity is a problem that may arise in the content of a single-equation model. Multicollinearity is the name given to the general problem which arises when some or all of the explanatory variables in a relation are so highly correlated one with another that it becomes very difficult, if not impossible, to disentangle their separate influences and obtain a reasonably precise estimate of their relative effects.

To test whether or not multicollinearity existed in the supply model developed, simple correlation coefficients of the various explanatory variables were calculated. The highest correlation coefficients between independent variables were in the range of 0.20 to 0.26 which

do not appear to indicate that multicollinearity was a problem in the model. Generally, a simple correlation coefficient in excess of 0.75 would be required before multicollinearity could be considered a factor in the model.

If forecasting is a primary objective, as it is in this case, then intercorrelation of explanatory variables may not be too serious, provided it may reasonably be expected to continue in the future.[1] Consequently, even if some degree of multicollinearity exists in the model, there is no reason to expect that conditions would change. Therefore, the problem of multicollinearity does not appear to be a major restriction on the supply model developed.

Predictions

It is one thing for a model to explain past variations, but quite another for it to predict values of a dependent variable beyond the point of fit.[2] Consequently, the model's predictive power needs to be tested apart from its explanatory power in order to appraise its overall worth.

In this study it was possible to make a supply prediction for each day from any particular estimation. As mentioned previously, the terminal market in Edmonton was usually closed by late afternoon. Supply for the next day could then be estimated by utilizing the closing price for that day in the supply equation.

Because the predictions were made for one successive day at a time, the value of all other independent variables in the supply equation was known for each new day. These known values of the independent

---

[1] Johnston, op. cit., p. 207.

[2] Leuthold, op. cit., p. 108.

variables were inserted into the supply function to obtain an estimate of the dependent variable. This estimate was then compared to the observed value of the dependent variable for that particular day. Before discussing the predictions, however, methods of analyzing and comparing forecasts are presented.

Analyzing Forecasts

There are various methods available for testing and evaluating forecasts. The most common procedures, which were used in this study, evaluate the accuracy of predictions in forecasting the direction of change and the actual values of the dependent variables.

The model was said to have predicted the correct direction of change if the predicted and actual values of the dependent variable in time t were both larger (or smaller) than the actual value in time t-1. The procedure here was to represent the number of correct directional changes predicted as a percent of the total number of predictions. For example, if the correct direction of change was predicted in 40 out of 50 cases, then the directional change was predicted correctly 80 percent of the time.[1]

In order to evaluate the accuracy of a prediction in approximating the actual value of a dependent variable, two items were computed. The deviation between the actual and predicted values of the dependent variable was computed along with the deviation as a percent of the actual value. The latter computation represented the percent of error involved.

---

[1] For recent literature on this type of evaluation see: Olman Hee, "Tests for Predictability of Statistical Models," Journal of Farm Economics, XLVIII, No. 5 (December, 1966), 1479-1484.

Since there were 252 observations for which to predict quantity, it was impractical to list each deviation and its percentage error. Consequently, the absolute value of all the deviations and the absolute value of all the percentage errors were summarized and averaged over a given time period, and only these summaries were indicated.[1]

$$\text{Average Absolute Deviation} = \frac{1}{n} \sum_{i=1}^{n} |X_t - \hat{X}_t|$$

$$\text{Average Absolute Percentage Error} = \frac{1}{n} \sum_{i=1}^{n} \left(\frac{X_t - \hat{X}_t}{X_t} \cdot 100\right)$$

Comparing Forecasts

Another way to test the forecasting ability of a model is to compare it with other forecasts. For this study it was desirable to compare the computed predictions with forecasts that the industry might use. Unfortunately, the hog industry in Canada did not utilize any daily forecasts, even of a very simple nature; thus this means of testing the predictive power of the supply equations developed was impossible.

Supply Predictions

The supply of live hogs for the Edmonton market area was forecast twice for each market day of 1968. One forecast used the coefficients of the January-December, 1967, estimation; the other forecast used a different set of coefficients for each month. For any given month, this latter set of coefficients corresponded to the estimation using the previous 12 months of data. For example, for the month of

---

[1] For further discussion of various methods for determining accuracy in forecasting see H. Thiel, Economic Forecasts and Policy (Amsterdam: North Holland Publishing Co., 1958).

July, 1968, one set of predictions resulted from using the July, 1967-June, 1968, coefficients. Then the month of August, 1968, had one set of predictions resulting from the use of the August, 1967-July, 1968, coefficients, and so on.[1] Of course, the two sets of predictions for January, 1968, used the same coefficients and, therefore, were identical.

The forecasts which were related to January-December, 1967, coefficients were referred to as Model IA; the forecasts which used different coefficients for each month were referred to as Model IB.[2] The average absolute deviation, average absolute percentage error, and percentage of correct directional predictions were computed as previously described for both models and are summarized on a monthly basis in Table 6-3.

The numbers in the last row of Table 6-3 are a weighted average of the 12 months of the corresponding columns. In comparing Models IA and IB for the entire year, it can be seen that there was a slight difference between the two in forecasting accuracy. The model which used the "previous" 12 months of data had, on the average, an absolute deviation of 105 fewer hogs than the model which used the one set of coefficients resulting from the January-December, 1967, data. There was also a slight difference in the weighted average absolute percentage error of the two forecasting models, Model IB having a 7 percent smaller percentage error than Model IA.

---

[1] The particular sets of coefficients were illustrated earlier in Table 6-1.

[2] For the remainder of the study an (A) following the model number indicates that January-December, 1967, data were used to obtain the coefficients. A (B) following the model number indicates that the coefficients change for each month being predicted and that the coefficients used for any one month were the result of the estimation that used the "previous" 12 months of data.

Table 6-3

SUMMARY BY MONTHS OF SUPPLY PREDICTION ERRORS FOR EACH MARKET DAY OF 1968 FOR THE EDMONTON MARKET AREA

Month	Model IA Average Absolute Deviation	Model IA Average Absolute Percentage Error	Model IA Percentage Correct Direction	Model IB Average Absolute Deviation	Model IB Average Absolute Percentage Error	Model IB Percentage Correct Direction
January	676	35	90.5	676	35	90.5
February	1,053	45	76.2	1,020	42	81.0
March	1,278	48	80.0	1,218	43	100.0
April	1,583	55	71.4	1,407	45	95.2
May	1,736	40	87.0	1,577	39	95.7
June	1,197	36	80.0	852	27	100.0
July	1,974	48	81.8	1,238	44	100.0
August	788	83	90.5	756	29	100.0
September	674	30	85.0	864	27	100.0
October	1,218	56	90.9	1,839	48	81.8
November	905	46	87.0	891	31	95.2
December	1,188	46	70.0	985	39	95.0
Year 1968	1,319	47	82.5	1,214	40	94.5

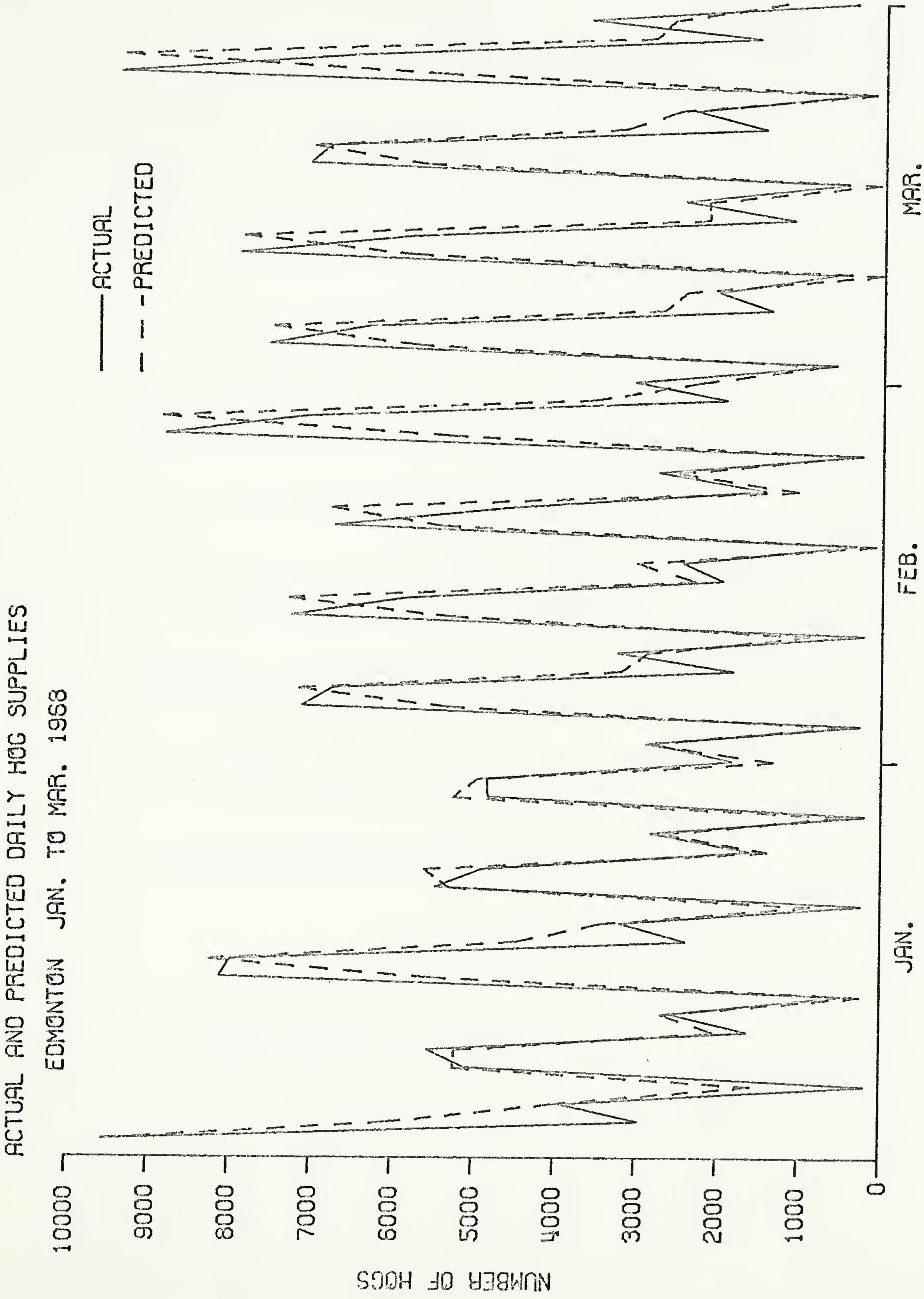
Model IB illustrated more accuracy in predicting the correct directional change with 94.5 percent correct predictions compared to 82.5 percent correct predictions for Model IA. Thus it would appear that for a period of one year the forecasting accuracy for directional change of Model IB was better than for Model IA.

In analyzing the forecasting accuracy of the two models on a monthly basis, Model IB once again showed a slight advantage over Model IA. Looking at the predictions for December, 1968, where the coefficients for the two models were estimated from data that had only one month in common, it was found that Model IB had a 7.0 percent advantage over Model IA in predicting actual supply changes. This advantage in accuracy for Model IB occurred for every month in 1968 except January where the models had the same coefficients and consequently the same percentage error.

Thus the results indicate that it may be an advantage to reestimate the model month by month especially if predicting the correct directional change in supply is the main objective of the forecaster. For a period of at least a year, reestimating the supply function for each month to get a new set of coefficients seemed advantageous, for the forecasting accuracy for the change in supply of hogs of the model using new coefficients for each month was greater without exception than the forecasts using the first set of coefficients throughout.

The weighted average absolute percentage error for the year of between 40 and 50 percent appeared rather high for forecasting purposes. Figures 6-2 to 6-5, which compare the actual supply and the predicted supply corresponding to Model IB for 1968, illustrate that quantity

Figure 6-2



ACTUAL AND PREDICTED DAILY HOG SUPPLIES
EDMONTON JAN. TO MAR. 1968

Figure 6-3

ACTUAL AND PREDICTED DAILY HOG SUPPLIES

EDMONTON APR. TO JUNE 1988

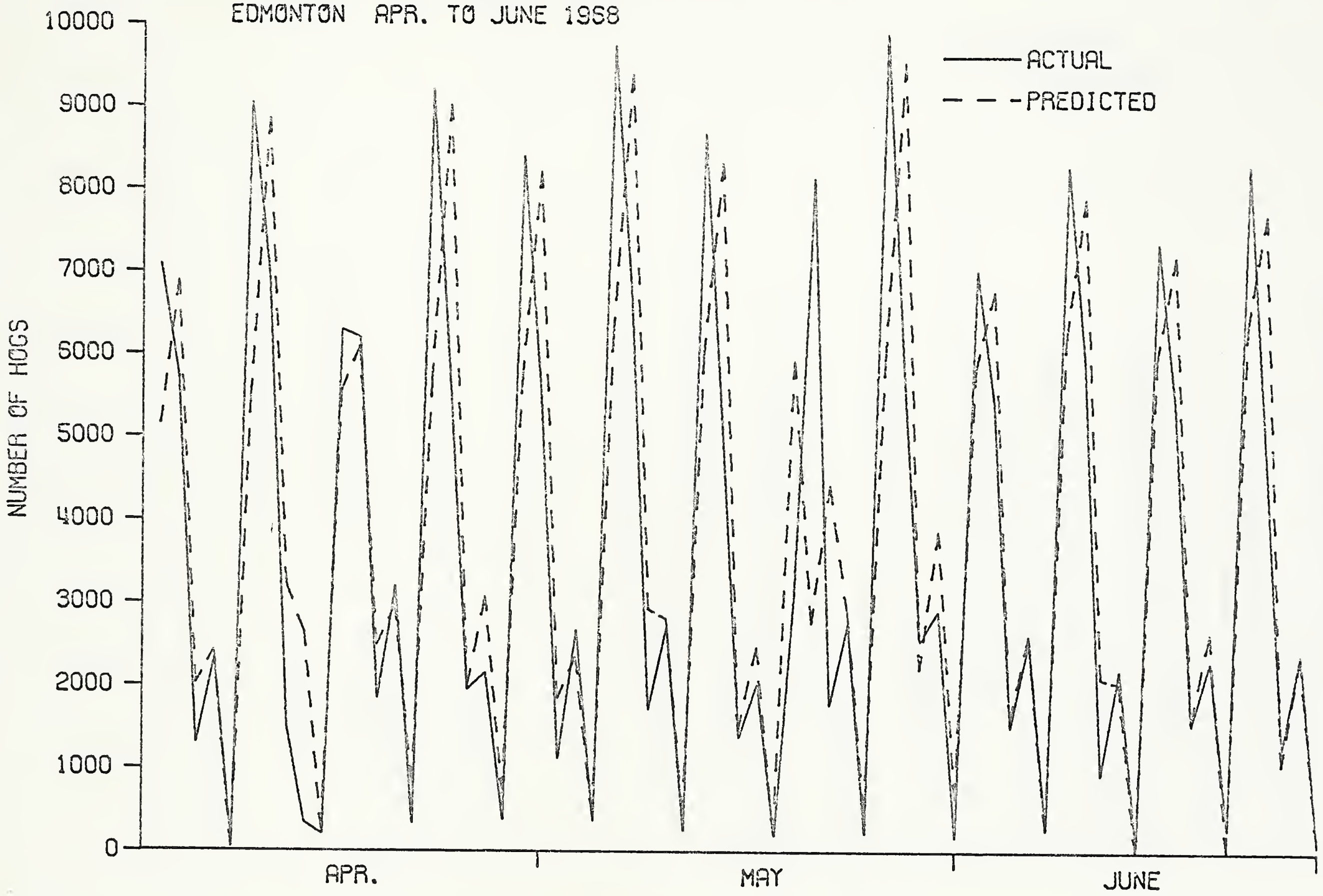
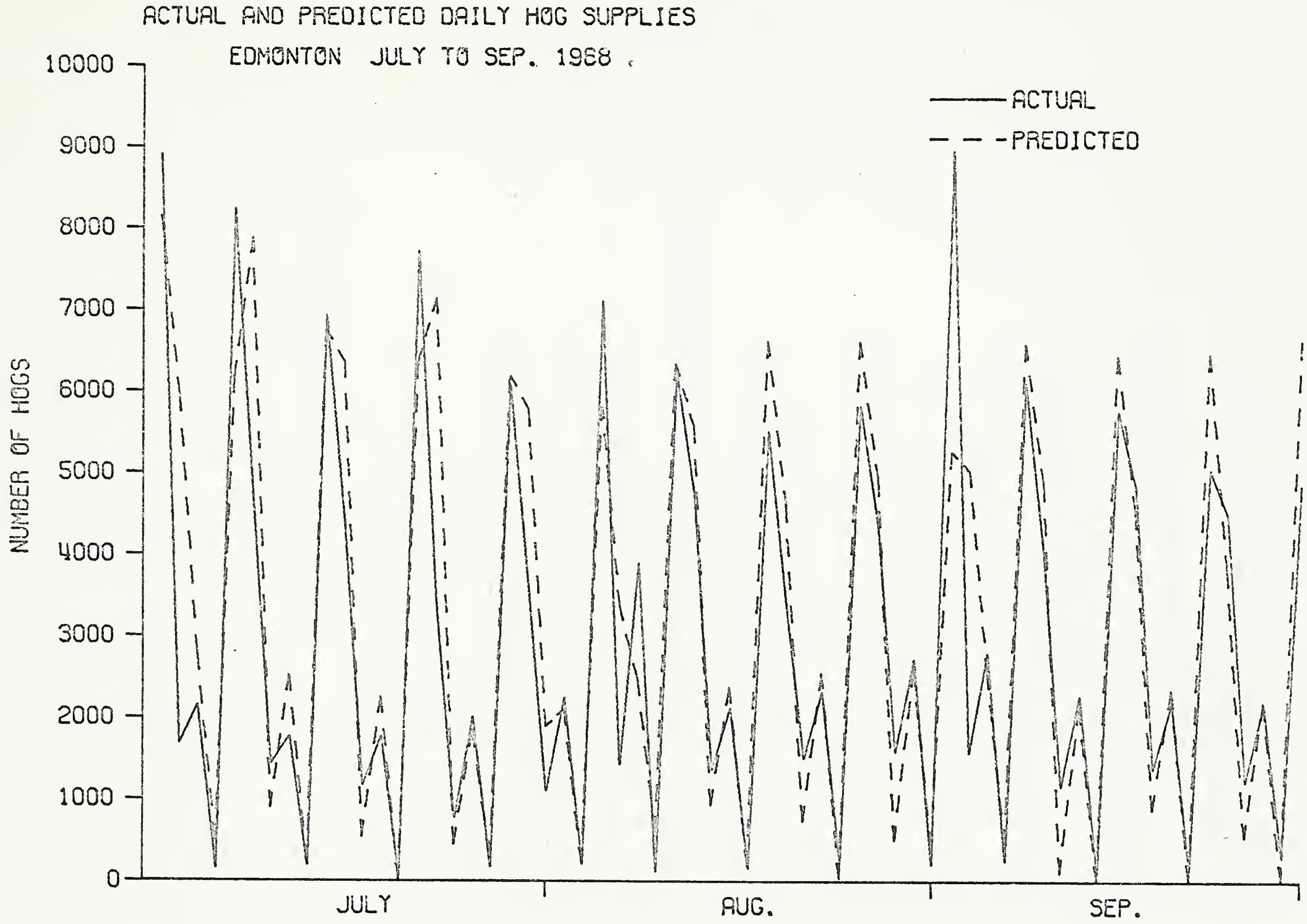


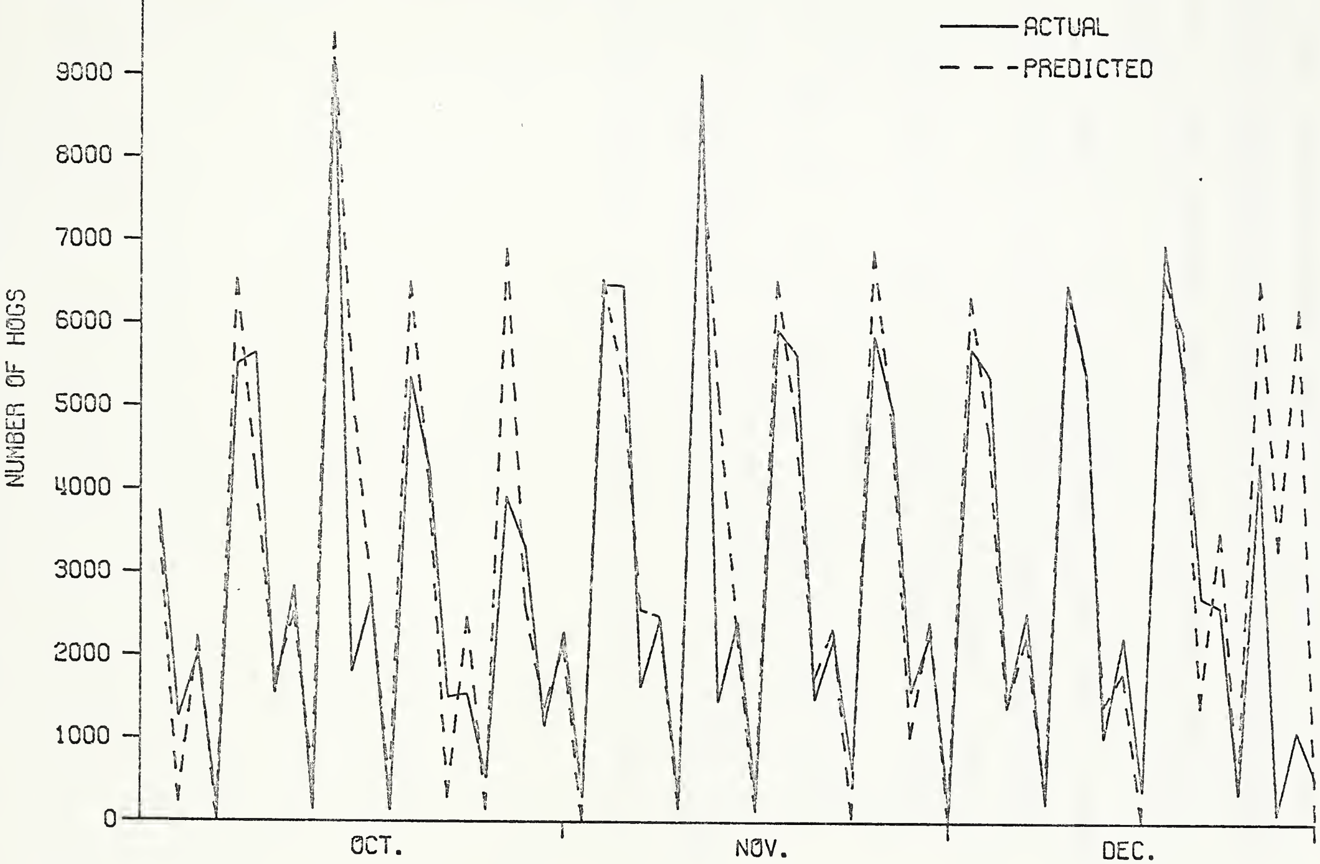
Figure 6-4



ACTUAL AND PREDICTED DAILY HOG SUPPLIES
EDMONTON JULY TO SEP. 1968

Figure 6-5

ACTUAL AND PREDICTED DAILY HOG SUPPLIES
EDMONTON OCT. TO DEC. 1968



fluctuates from 50 to over 100 percent every day. Thus the percentage error of the predictions, which ranged from 27 percent in June and September for Model IB to 56 percent in October for Model IA, was of a similar or lower magnitude than the actual percentage quantity fluctuations.

In addition to the above observations, the models accurately predicted the correct direction of change by forecasting correctly over 80 percent of the possible 252 directional changes for Model IA and over 90 percent for Model IB (Saturdays, Sundays, and holidays were excluded). For the months of March, June, July, August, and September, 1968, the correct direction of change was predicted for each market day by Model IB. For the other months, the degree of predicting correct directional change varied, but on the whole, Model IB adequately predicted the proper direction of change in supply.

CHAPTER VII

SUMMARY AND RECOMMENDATIONS

The primary focus of this study has been an examination of the factors affecting daily quantity variations of live hogs in the Edmonton market area. The daily dressed weight hog prices, price fluctuations, and price relationships among the three major hog marketing centers in Canada were described in detail. Price information flows among the markets were then considered. An economic supply model was formulated to identify the relevant variables and to test the data from the Edmonton market area over several time periods. Finally, various supply predictions were conducted for the Edmonton market area using the results of the estimations.

Summary of Hypotheses and Conclusions

In the introductory chapter, several hypotheses were made and tested in subsequent chapters. A list of those hypotheses follows:

1. It was hypothesized that the westerly situated markets were dependent upon the Toronto market in the reflection of their dressed hog prices.
2. It was hypothesized that differences in dressed weight hog prices as quoted among the three terminal markets examined were reflected by the freight rate differentials among these spatially separated markets.
3. It was hypothesized that certain price information flows existed in Canadian hog markets. These price information flows were hypothesized to be of the following nature:

a) western markets were hypothesized to react to eastern hog prices established within the day, and

b) eastern markets were hypothesized to react to western hog prices established the day before.

4. A general hypothesis was formulated with respect to both pricing and operational efficiency within the Alberta hog market. It was hypothesized that both pricing and operational efficiency had been increased by the establishment of the Alberta Hog Producers Marketing Board. That is, an increase in overall market efficiency was hypothesized to be attributable to the change in market structure of the Alberta hog industry.

5. A final hypothesis was made in connection with the supply model developed. It was hypothesized that the change in the number of hogs supplied to the Edmonton market was a function of the previous days' dressed hog price, the day of the week, the effects of precipitation, temperature, and holidays, the price of feed barley four months previous, the season of the year, and the number of hogs available for market.

The results of the analysis performed in the study led to the following conclusions about the stated hypotheses:

1. With respect to the first hypothesis dealing with intermarket pricing relationships, it was concluded that there was little dependency by the western markets on the eastern markets in the reflection of dressed hog prices. This conclusion was based on the results of a first difference analysis of prices for these three major hog markets. Correlation coefficients of first differences of prices were

calculated, and these coefficients were of low magnitude (ranged between 0.20 and 0.30). Because of this low level of correlation, intermarket pricing response does not appear to be prevalent in the Canadian hog market.

2. Hypothesis number two dealing with the relationship of intermarket price spreads and freight differentials was rejected. The statistical procedure used to test this hypothesis indicated that in actuality, the average intermarket price spreads among the three markets under study were significantly different from the existing freight rate differentials for these three markets. The conclusion that freight rates did not appear to account for the intermarket price spreads suggests that the three hog markets under study were not dependent upon one another in the establishment of their hog prices. Thus the conclusion made with respect to hypothesis two supports that made with respect to hypothesis one.
3. The results of analysis performed on the dressed hog prices in the three markets suggests that no statistically identifiable hog price information flows exist within the Canadian hog market. A lagged first difference correlation analysis showed that no particular market in Canada relies on price information from another market in the pricing of its hogs. This conclusion was based on the fact that none of the correlation coefficients of lagged first differences of prices exceeded those of unlagged first differences. If price information flows existed as hypothesized, the correlation of western prices lagged one day with eastern prices should be substantially higher than unlagged coefficients.

4. The general hypothesis dealing with the level of pricing efficiency and operational efficiency existing in the industry prior to and following the establishment of the Alberta Hog Producers Marketing Board received a partial, but not a complete set of quantitative analysis. No quantitative analysis was done on relative cost structures between the two market structures. Some evidence was cited suggesting that some cost savings have resulted because of the elimination of certain services once considerably duplicated by many firms within the industry. However, the evidence was far from conclusive. Although it was felt that operational efficiency might have increased with the introduction of the Board, a definite conclusion could not be drawn on this matter.

The price analysis did lead to a sound conclusion regarding pricing efficiency in the two time periods studied. Data generated since the Board became operational were subjected to the same analyses as data discussed in our earlier hypotheses. It was found that the price spreads between Toronto and Edmonton and Winnipeg and Edmonton have decreased by $0.34 and $0.78 per hundredweight respectively. This strengthening of Alberta prices relative to Winnipeg and Toronto suggests that a definite increase in pricing efficiency can be attributed to the new marketing board structure. Results of the various correlation analyses performed on the latter set of data also indicate an increase in pricing efficiency. All coefficients, whether lagged or unlagged, were greater in magnitude than the corresponding coefficients pertaining

to the 1967-1968 data. This fact suggests that a slight increase in pricing responsiveness among the markets resulted from the change in market structure. The improvement, however, was slight, and the correlation coefficients of first differences of prices were still of low magnitude. This suggests that hog markets in Canada are still free to price their hogs according to local supply and demand conditions.

Further results show a high degree of correlation among absolute price levels on the three terminal markets both prior to and following the establishment of the Alberta Hog Board. In 1967-1968, the correlation coefficients between Edmonton and Toronto, Edmonton and Winnipeg, and Toronto and Winnipeg were 0.94, 0.95, and 0.93 respectively. In 1969-1970, the corresponding coefficients were 0.97, 0.98, and 0.98. This again illustrates the minor increase in price responsiveness following the change in market structure. One must remember, however, that the prices gathered for the Edmonton market area during the latter time period were more accurate because of the larger number of hogs represented by the price and the more accurate method of gathering prices compared to the 1967-1968 time period. These relatively high correlation coefficients of absolute price levels compared to the coefficients of first differences of prices suggest that intermarket price responsiveness was perhaps tied more closely to price levels than to price changes.

The supply equations developed in this study were based on the hypothesis that change in supply was a function of several independent variables, all of which are outlined in Chapter V. The results of the multiple regression analysis showed that the major variable affecting the day-to-day change in supply on the Edmonton terminal

market was the day of the week. The dummy variables representing days of the week accounted for over 90 percent of the explained variation of the dependent variables. Other variables entered some, but not all of the supply equations developed. The price expectation of the producer, the price of feed barley, and a dummy variable representing precipitation changes entered some of the estimated supply functions, but their inclusion was not complete and varied for certain levels of confidence. The overall conclusion was that the day of the week is the primary factor affecting quantity changes.

Predictions of supply change were made for each market day of 1968. The two models developed showed a moderate degree of forecasting accuracy. Model IB, which utilized a different time series for each set of monthly predictions, had a 40 percent average absolute percentage error in forecasting actual supply changes. This model, however, exhibited a high degree of forecasting accuracy with respect to directional change. The correct directional change was forecasted 94.5 percent of the time, with five of the months having a 100 percent correct estimation. Model IA had a 47 percent average absolute percentage error in forecasting actual supply changes and its forecasting ability with respect to directional change was somewhat lower than Model IB, with 82.5 percent correct predictions.

A conclusion which can be drawn from this information is that if the prime objective of the forecaster is to forecast correct directional change, then Model IB should be used. That is, a new set of coefficients developed for each month to be forecasted provides a higher level of predictive accuracy than a single set of coefficients

as developed in Model IA. Daily hog supply forecasting does not exist in Canada at present. Emphasis should perhaps be placed on utilizing Model IB so that the direction of supply change can be forecasted by interested parties within the industry. Because both models indicate similar levels of accuracy in forecasting actual supply changes, the use of either model within the industry is advisable.

Policy Implications

The results of the various statistical analyses performed in this study led to the conclusion that the three hog markets studied displayed little or no interaction in the establishment of their prices. No informational flows could be identified, and it was found that intermarket price spreads were significantly different from existing freight rate differentials. Putting all of this information together leads to the overall conclusion that the production and subsequent marketing of hogs in Canada is or should be performed on a regional rather than a national basis.

This being the case, some changes in the pricing policies of our major packinghouse companies are suggested. When overall prices are high, the intermarket price spreads tend to narrow; when prices drop, the intermarket price spreads show a pronounced widening trend. The nature of the price spreads as they react to price levels suggests that regional supply and demand, as well as the influence of exports in certain regions in Canada, play a major role in Canadian hog pricing. The fact that hog production in the West, especially in periods of oversupply, moves west and south suggests that the pricing of these hogs should be related to directly competitive hog markets. Because hogs

produced in Eastern Canada are generally disposed of in domestic markets, competition from the corn belt states the Western United States appears to affect Western Canadian production most directly. The results of this study clearly indicate that the pricing of Western Canadian hogs is not based on a Toronto base price less freight. Therefore, it may be assumed that packers have adjusted their buying practices and are aware of the potential competition existing in the Western United States. The result has been that hogs in Western Canada are priced according to regional supply and demand conditions, while bearing in mind the effects of exports and imports on the overall price level of hogs.

Recommendations for Further Research

The fact that very few positive results supporting the stated hypotheses were found suggests the need for a continuing program of research on the Canadian hog market. All hypotheses relating to price establishment, price spreads, and price information flows were statistically rejected. Because these hypotheses were generally based on the knowledge and feelings of people directly involved in the hog industry, either the industry is presently ignorant of its own operations, or conditions have changed within the industry and industry has not responded accordingly.

Based on the lack of price responsiveness indicated among hog markets in Canada, a study of price relationships between Western Canadian and Western United States markets is recommended. Little is known about the interaction of these markets, and if such interaction exists, understanding it would be very valuable to the Western Canadian hog producer in developing continuous export markets for hog products.

BIBLIOGRAPHY

ALBERTA DEPARTMENT OF AGRICULTURE. Statistics of Agriculture for Alberta. Edmonton: ADA, 1967 and 1968.

BRANDOW, G. E. "Market Power and Its Sources in the Food Industry." American Journal of Agricultural Economics, LI, No. 1 (February, 1969) 1-12.

BREMNER, S. Bremner's Prophecies of Future Ups and Downs in Prices. 16th ed. Cincinati: R. Clarke Co., 1907.

CANADA DEPARTMENT OF AGRICULTURE. Forty-eighth Annual Livestock Market Review. Ottawa: CDA, Markets Information Section, Production and Marketing Branch, 1968.

CANADA DEPARTMENT OF AGRICULTURE. Forty-ninth Annual Livestock Market Review. Ottawa: CDA, Markets Information Section, Production and Marketing Branch, 1969.

CANADA DEPARTMENT OF TRANSPORT. Monthly Record: Meteorological Observations in Canada. Toronto: Canada Department of Transport, Meteorological Branch, 1967 and 1968.

DARCOVICH, W. and E. O. Heady. Application of Expectation Models to Livestock and Crop Prices and Products. Research Bulletin 438. Ames, Iowa: Iowa Agricultural Experiment Station, February, 1956.

DAWSON, James L., Allan A. Warrack, and Murray H. Hawkins. Location Analysis for Alberta Hog Assembly Centers. Agricultural Economics and Rural Sociology Bulletin 11 (Technical Research). Edmonton: University of Alberta, March, 1971.

EZEKIEL, M. "The Cobweb Theorem." Quarterly Journal of Economics, LII, No. 2 (March, 1938), 255-80.

FREUND, J. E. and F. J. Williams. Modern Business Statistics. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1963.

FULLER, W. A. and G. W. Ladd. "A Dynamic Quarterly Model of the Beef and Pork Economy." Journal of Farm Economics, XLII, No. 4 (November, 1961), 797-812.

GOLDBERGER, A. S. Econometric Theory. New York: John Wiley and Sons, Inc., 1964.

HACKETT, B. A. Highlights 1967: Alberta Hog Enterprise Analysis. Edmonton: Alberta Department of Agriculture, Economics Division, Farm Management Branch, 1967.

HARLOW, A. A. Factors Affecting the Price and Supply of Hogs. U.S. Department of Agriculture Technical Bulletin 1274. Washington, D.C.: Superintendent of Documents, U.S. Government Printing Office, December, 1961.

HAWKINS, M. H., A. A. Warrack, and J. L. Dawson. Development and Operation of the Alberta Hog Producers Marketing Board. Agricultural Economics and Rural Sociology Bulletin 21 (General Information). Edmonton: University of Alberta, April, 1971.

HEE, O. "Tests for Predictability of Statistical Models." Journal of Farm Economics. XLVIII, No. 5 (December, 1966), 1479-84.

HURNANEN, R. R. "Vertical Integration and Concentration in the Alberta Broiler Industry." Unpublished M.Sc. thesis, University of Alberta, Department of Agricultural Economics and Rural Sociology, 1970.

JOHNSTON, J. Econometric Methods. New York: McGraw-Hill, 1960.

KERR, T. C. Determinants of Regional Livestock Supply in Canada. Publication No. 15. Ottawa: Agricultural Economics Research Council of Canada, July, 1968.

LEUTHOLD, R. "Economic Analysis of Daily Hog Price Fluctuations." Unpublished Ph.D. thesis, University of Wisconsin, 1968.

MAKI, W. R. "Forecasting Livestock Supplies and Prices with an Econometric Model." Journal of Farm Economics, VL, No. 3 (August, 1963), 612-24.

MANNING, T. W. The Hog Marketing System in Alberta. Agricultural Economics Research Bulletin No. 4. Edmonton: University of Alberta, July, 1967.

NATIONAL COMMISSION ON FOOD MARKETING. Food from Farmer to Consumer. Washington, D.C.: Superintendent of Documents, U.S. Government Printing Office, 1966.

NORTH CENTRAL LIVESTOCK MARKETING RESEARCH COMMITTEE. Price Differentials for Slaughter Hogs. Ames, Iowa: Iowa Agricultural Experiment Station, August, 1948.

SCHNEIDOU, R. E., V. W. Pherson, and C. B. Cox. Is There a Best Market Day? Bulletin 712. Lafayette, Indiana: Purdue University Agricultural Experiment Station, October, 1958.

STOVER, H. J. Relation of Daily Prices to the Marketing of Hogs at Chicago. Bulletin 534. Ithaca, N.Y.: Cornell University Agricultural Experiment Station, January, 1932.

SUITS, D. B. "Use of Dummy Variables in Regression Equations." Journal of the American Statistical Association, L, II (1957).

THIEL, H. Economic Forecasts and Policy. Amsterdam: North Holland Publishing Co., 1958.

WALLACE, H. A. Agricultural Prices. Des Moines, Iowa: Wallace Publishing Co., 1920.

WARREN, G. F. Farm Management. New York: The Macmillan Co., 1913.

WELLS, O. V. Farmer's Response to Price in Hog Production and Marketing. U.S. Department of Agriculture Technical Bulletin 359. Washington, D.C.: Superintendent of Documents, U.S. Government Printing Office, April, 1933.

WENTWORTH, E. N. and T. U. Ellinger. "The Determination of Hog Prices at Public Markets." Journal of Farm Economics. VI, No. 3 (July, 1924), 279-82.

WRIGHT, S. Corn and Hog Correlations. U.S. Department of Agriculture Bulletin 1300. Washington, D.C.: Superintendent of Documents, U.S. Government Printing Office, 1925.

APPENDIX A

The Concept of Marketing Efficiency[1]

Market performance as measured by overall marketing efficiency is the combined result of exchange or price efficiency defined as (ε) and operational efficiency defined as (Ω). Pricing efficiency is determined by the structure and strategy alternatives within the industry, while organization and logistics determine the operational efficiency of the system, giving

$$M = \phi\ (\varepsilon, \Omega),$$

where M is total marketing efficiency.

"Operational efficiency is a measure of how well the firms perform the basic physical functions of marketing. . . assembly, processing, and distribution."[2] It derives from the internal organization of the firm and is dependent upon the logistics of the system, that is, the physical movement of goods through the channels of procurement and distribution. Brandow states that a consequence of attaining superior operational efficiency in a dynamic industry is market power. He defines market power as follows:

> A firm may be said to possess market power if a price, production, marketing, or purchasing decision it might practically make can directly and materially affect

---

[1] The content of this Appendix is taken from Agricultural Economics 502 lecture notes given by Dr. A. A. Warrack of the Department of Agricultural Economics and Rural Sociology, University of Alberta, Edmonton.

[2] R. R. Hurnanen, "Vertical Integration and Concentration in the Alberta Broiler Industry," (unpublished M.Sc. thesis, University of Alberta, Edmonton, 1970).

> the incomes of other firms or persons or can appreciably change the average price, total quantity, or market in which it participates.[1]

In our context, it was hypothesized that operational efficiency within the hog industry in Alberta has been increased by the formation of the Alberta Hog Producers Marketing Board. This hypothesis was based on the premise that a low cost structure is the basis for competition; that is

$$\Omega = \phi \text{ (cost levels).}$$

In order for operational efficiency to have increased, the introduction of the marketing board structure must have resulted in the elimination of various services once duplicated by numerous marketing agencies within the marketing channel. Upon observation of the various changes which have taken place since the change in market structure, we notice that some services, formerly duplicated, have been eliminated. Examples of this include the closing down of several packer owned buying stations and assembly yards which were operated within close proximity of similar facilities. Another service that has been removed from packer jurisdiction concerns the issuing of cheques and sales invoices. The Alberta Hog Producers Marketing Board has computerized these transaction services and eliminated numerous administrative problems inherent in the old marketing framework. Consequently, the overall cost structure of the industry appears to have been lowered suggesting an increase in operational efficiency.

---

[1] George E. Brandow, "Market Power and Its Sources in the Food Industry," American Journal of Agricultural Economics, Vol. 51, No. 1 (February, 1969), p. 2.

Judgement of total market performance based on operational efficiency is incomplete without consideration of the exchange efficiency exhibited by firms in the industry. Exchange efficiency is usually illustrated as a function of market structure plus market conduct. The above definition of exchange efficiency is based on the premise that the accuracy, speed, and equity with which cost structures reflect prices determine overall pricing efficiency.

Market structure is defined as the organizational characteristics of the market that may influence the nature of competition. Market conduct is defined as a firm's policies toward moves made by rivals in that market. Market performance or exchange efficiency then is described as a firm's or industry's contribution relative to its potential in promoting social welfare.

In the case of perfect competition, exchange efficiency can be said to be maximized. Such competition ensures that costs and prices will gravitate to the lowest point on the long-run average cost curve and that "normal" zero profits will be realized.[1] Where perfect competition does not prevail, the criterion against which pricing efficiency is measured is the position of the firm or industry on the long-run average cost curve relative to the minimum point on the average cost curve. The closer one approaches the minimum, the higher the pricing efficiency.

In an industry as complex as the live hog industry, the structural component ranges from near perfect competition at the producer end of the marketing channel to a highly oligopolistic form of competition

---

[1] Hurnanen, op. cit., p. 18.

at the packing house and retail level. Since highly concentrated industries generally exhibit noticeable signs of inefficiencies in pricing, it is probable that certain pricing inefficiencies occur at various stages in the hog industry. It was this very concern, pricing inefficiency, which led to the establishment of the Alberta Hog Producers Marketing Board.

The Alberta hog producers had realized the costs involved in operating independently in an industry where market power was concentrated solely with the buyers of their product. By establishing a single selling agency whereby all hogs produced for slaughter had to be competitively bid for by all packers and export buyers, producers felt that they could offset some of the bargaining power once controlled solely by the packers. Although quantitative results are not put forward at this time, subsequent chapters will discuss changes in pricing efficiency that have taken place since the change to a marketing board structure in the province.

In order to analyze in total the effects of an increase in operational and/or exchange efficiency on overall marketing efficiency, a look at the effects of operational efficiency on pricing efficiency and vice versa is imperative. As earlier defined, $M = \phi(\Omega,\varepsilon)$. Consequently, the correlation of Ω and ε can indicate if absolute change in either is favorable or not in changing market efficiency.

The first case arises where the correlation of Ω and ε is positive; i.e., $\rho(\Omega,\varepsilon) > 0$. In such a case, measures to increase operational efficiency and/or exchange efficiency simultaneously or one at a time will result in an overall increase in market efficiency, for an increase in one does not have an offsetting effect on the other. Similarly, in instances where the correlation of Ω and ε is equal to zero,

an increase in either Ω or ε or both will not have an effect on the other but will increase total market efficiency. The final case, in which the correlation of Ω and ε is less than zero, results in a somewhat different situation. In this case, an increase in operational efficiency will result in a decrease in exchange efficiency and vice versa. Thus when $\rho(\Omega,\varepsilon) < 0$, one must be careful that any change to increase efficiency in one sector does not induce a more than corresponding change in the other; otherwise the net result will be a decrease in overall marketing efficiency.

It was hypothesized that the establishment of the Alberta Hog Board resulted in an increase in both operational and exchange efficiency. This suggests that the change in market structure resulted in a lower cost structure for the industry, as well as increasing competition within the industry. It also suggests that the Alberta hog industry was in a position where $\rho(\Omega,\varepsilon) > 0$ or $\rho(\Omega,\varepsilon) = 0$ so that any attempts to increase operational and/or pricing efficiency were in the interests of society as a whole.

c.2.

DATE DUE

c.2

THESIS 1971

AUTHOR
Andersen, Richard

TITLE
Daily Hog Price and supply Analysis

DATE

c.2